SOIL FERTILITY STATUS AT THE PROPOSED REHABILITATION SITES IN KELANTAN RIVER PLAIN, MALAYSIA

Amirul Faiz Rosli
Forestry Biotechnology Division
Forest Research Institute Malaysia, 52109 Kepong, Selangor, Malaysia
Email: amirulfaiz@frim.gov.my

Mohamad Fakhri Ishak
Forestry Biotechnology Division
Forest Research Institute Malaysia, 52109 Kepong, Selangor, Malaysia
Email: mohamadfakhri@frim.gov.my

Wan Rasidah Kadir
Forestry Biotechnology Division
Forest Research Institute Malaysia, 52109 Kepong, Selangor, Malaysia
Email: rashidah@frim.gov.my

Khairul Na'im Ya'kub
Forestry Department of Peninsular Malaysia Headquarters,
Jalan Sultan Salahuddin, 50660 Kuala Lumpur
Email: khairulnaim@forestry.gov.my

ABSTRACT

The study aims to assess fertility status of soils at the designated rehabilitation sites in Kelantan, Malaysia, which were earmarked for tree planting. Determination of soil fertility status could provide fundamental information on soil suitability for species selections and improve the effective technique for the rehabilitation program. There were seven sites chosen as sampling locations along the Sungai Lebir's riverbank. Samples were taken using Jarret auger at different depths based on the differential horizon. Standard soil analysis was adopted to analyse the physico-chemical properties of the soil samples. The reconnaissance survey reveals that the soils have a wide range of texture including clay, loam and sand. Generally, the pH of the soils was acidic – pH of fresh soils ranged from 4.69 to 5.65, and pH of air-dried soils ranged from 5.04 to 5.99. The acidic nature of the soils is common feature of tropical soils, largely brought about by lixiviation process, where decades of torrential rains leached portion of nutrients and exchangeable bases out of the soil. The value of available P, exchangeable K and total of nitrogen ranged from 0.95 to 2.68 ppm, 0.02 to 0.23 cmol/kg and 0.03 to 0.10 respectively. Overall, the soils sampled show heterogenous texture with low nutrients content which need proper management for tree planting.

Keywords: *Soil fertility, soil nutrient, riverbank planting*

INTRODUCTION

Forest rehabilitation is defined as a process to bring back tree cover on barren areas, deforested grasslands, scrublands or brushlands through planting, seeding and assisted natural regeneration to sustain livelihoods, producing industrial timber or restoring forest environmental functions (Chokkalingam *et al.*, 2005). The purpose of forest rehabilitation is to restore the capacity of degraded forest land to deliver forest products and services, and reduce environmental catastrophe resulting from deforestation (de Jong, 2010). Each type of degraded land may require different approaches and technologies for rehabilitation (Krishnapillay *et al.*, 2007).

In Kelantan, site degradation is largely caused by natural factors – flooding. Weng Chan (1997) stated that in recent decades, the floods are largely due to changing physical characteristics of the hydrological sysytem caused by human activities; continued development of already densely populated flood plains, destructions of forest and hill slopes development dan encroachment on flood-prone areas. In late 2014, Kelantan was hit by the worst ever flood recorded (Baharuddin *et al.*,2015; Alias *et al.*, 2016). Riverbanks are vulnerable to erosion and one way to slow down the effect is by having lines of trees. Embarking on tree planting, the fertility status of the soils needs to be examined to match the forest tree species and the sites.

The objective of this study is to assess fertility status of soils at the designated rehabilitation sites in Kelantan river plain, Malaysia, as part of providing fundamental information on soil suitability for targeted forest tree species selection. Results in this paper can be useful in recommending optimum soil management practices and to improve the planting approach for the rehabilitation program.

MATERIALS AND METHODS

The location of soils sampling are the sites proposed for forest restoration program under the Forestry Department of Peninsular Malaysia. The areas cover Sungai Lebir's riverbank, from north, Kampung Batu Lada southerly to Laloh (Table 1).

Table 1. Sampling code, location and coordinate of the soil sampling area

Sampling Code	Location	Coordinate
P1	Kg Batu Lada	5°32'17.21"N, 102°11'32.79"E
P2	Kg Manek Urai Lama	5°23'47.49"N, 102°13'51.69"E
P3	Kg Pemberian	5°20'18.00"N, 102°15'02.58"E
P4	Kg Manjur	5°19'41.47"N, 102°15'11.18"E
P5	Laloh	5°18'01.59"N, 102°16'17.43"E
P6		5°18'00.24"N, 102°16'16.33"E
P7		5°17'59.36"N, 102°16'16.45"E

Soil samples were collected at seven points using Jarret auger at a different depth, segregated based on the soil horizon and were kept in a polyethylene bag for transportation to the laboratory. The pH of fresh soils was measured before air-dried. Next, the air-dried samples were crushed and sieved through a 2mm mesh, and pH value of dried soil was measured. Soil texture was determined using the pipette method (Gee and Bauder 1986). Total nitrogen was determined using the modified Kjeldahl method (Bremner and Mulvaney, 1982). Available phosphorus (Av. P) was measured by using Bray and Kurtz No. 2 extracting solution (Bray and Kurtz, 1945). Exchangeable K were extracted with 1 N NH_4OA_c buffered at pH 7 by distillation method. The leachate collected were analysed on ICP for exchangeable K. All soil analyses were conducted at the Soil Chemistry Laboratory, Forest Research Institute Malaysia (FRIM).

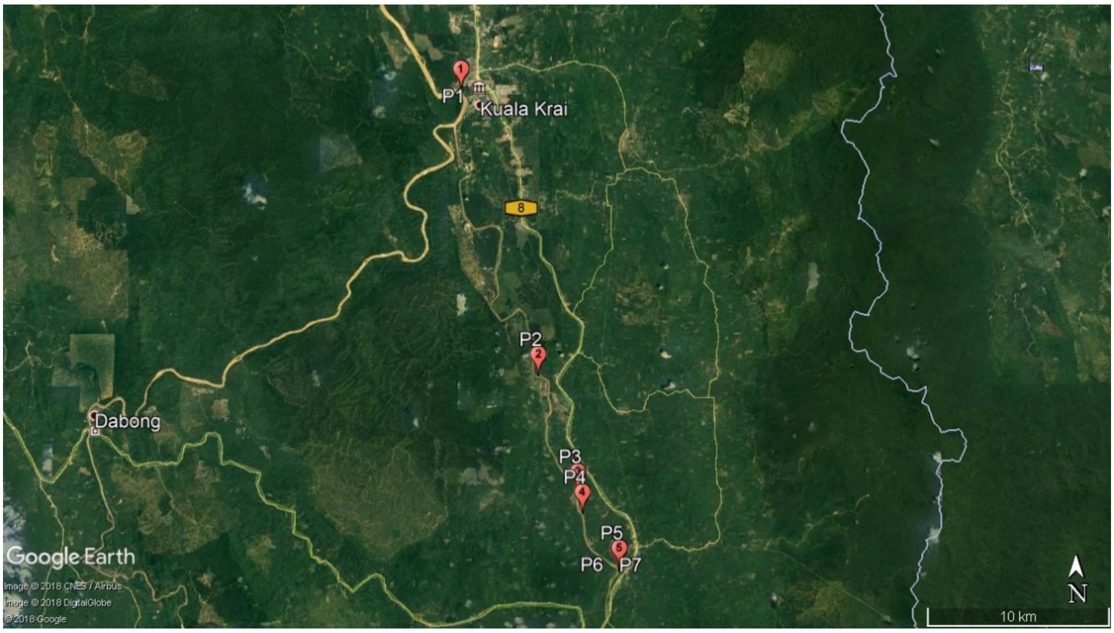

Figure 1. Map showing the location of soil sampling points in Kuala Krai area. (Source: Google Earth Pro)

RESULTS AND DISCUSSION

The results of the physico-chemical properties of the soils sampled are as shown in Table 2 and Table 3. Based on Table 2, all of the samples show a heterogenous texture, ranged from sandy loam to sandy clay loam due to the deposition of different soil particles. The texture descriptions are based on USDA soil textural triangle (Soil Survey Division Staff, 1993). Low clay content associated with high sand content resulted in low nutrients retention in soil and, inversely, high clay content associated with low coarse sand content can hold more nutrients in the soil. (Heryati *et al.*, 2011).

Table 2 - Particle-size distribution of sampled soils of rehabilitation sites in Kelantan

Sampling code	Depth (cm)	Coarse sand (%)	Fine sand (%)	Silt (%)	Clay (%)	Textural class
P1	0-17	5	21	35	34	Clay loam
	17-50	54	33	6	9	Loamy coarse sand
	50-65	16	26	29	27	Clay loam

	65-120	10	15	29	46	Clay
P2	0-15	2	31	37	29	Clay loam
	15-22	56	21	10	14	Coarse sandy loam
	22-37	7	28	35	29	Clay loam
	37-62	8	53	9	29	Sandy clay loam
	62-100	20	45	13	20	Sandy clay loam
	100-120	22	43	15	21	Sandy clay loam
P3	0-9	19	56	15	11	Fine sandy loam
	23-9.	3	45	32	22	Loam
	23-27	38	50	6	10	Loamy fine sand
	27-38	17	50	20	14	Fine sandy loam
	38-76	20	45	18	20	Sandy clay loam
	76-120	21	38	20	21	Sandy clay loam
P4	0-5	43	30	10	15	Coarse sandy loam
	5-28	7	34	32	26	Loam
	28-56	35	42	11	13	Coarse sandy loam
	56-90	14	41	25	20	Sandy clay loam
	90-120	12	41	26	24	Sandy clay loam
P5	0-25	7	36	29	25	Loam
	25-65	20	39	20	21	Sandy clay loam
	65-120	36	29	16	16	Coarse sandy loam
P6	0-10	59	35	2	7	Coarse sand
	10-47.	12	52	15	16	Fine sandy loam
	47-88	38	50	5	11	Loamy fine sand
	88-120	21	47	14	19	Fine sandy loam
P7	0-22	61	33	1	7	Coarse sand
	22-95	37	45	8	12	Coarse sandy loam
	95-120	30	39	10	18	Coarse sandy loam

In general, pH of the surface soil is higher than the subsoil (Table 3). The pH of the soils was considered acidic with the value of fresh soils ranged from 4.69 to 5.65, and pH of air-dried soils ranged from 5.04 to 5.99. Aiza *et al.* (2013) and Amacher *et al.* (2007) classified it as moderately acidic if the pH value is less than 5 and 4.01-5.5 respectively. The acidic nature of the soils is common feature of tropical soils, largely brought about by lixiviation process, where decades of torrential rains leached portion of nutrients and exchangeable bases out of the soil. Tan (2005) stated that some available nutrients are deficient if soil pH is below 6.

The value of total nitrogen ranged from 0.03 to 0.10%, fluctuated from surface soil to subsurface. According to Amacher *et al.* (2007), the soils is categorized as having low content of nutrient if the percentage value is less than 0.1 (<0.1) which indicate loss of organic nitrogen. Available P in sampled soil ranged from 0.95 to 2.68 ppm. Lal (1997) stated that low phosphorus availability is one of the limiting factors of forest productivity. But every tree species demands phosphorus differently and some have better capacity to extract phosphorus in fixed form from soils (Heryati *et al.*, 2011). Another major nutrient, the exchangeable K were high in surface soils and decrease with depth in all soil profiles and ranged from 0.02 to 0.23 cmol/kg.

Table 3 – Chemical properties of sampled soils of rehabilitation sites in Kelantan

Sampling code	Depth (cm)	Wet pH	Dry pH	N (%)	Av. P (ppm)	Ex. K (cmol/kg)
P1	0-17	5.45	5.77	0.1	1.83	0.12
	17-50	5.32	5.77	0.05	2.68	0.08
	50-65	5.2	5.66	0.08	1.75	0.09
	65-120	4.69	5.04	0.06	1.53	0.04
P2	0-15	5.24	5.63	0.1	1.63	0.07
	15-22	5.13	5.76	0.07	1.35	0.07
	22-37	5.16	5.63	0.09	1.75	0.05
	37-62	4.98	5.26	0.07	1.85	0.04
	62-100	5.06	5.36	0.05	1.93	0.02
	100-120	5.2	5.5	0.05	1.8	0.02
P3	0-9	5.54	5.76	0.05	1.05	0.10
	23-9.	5.45	5.94	0.09	1.43	0.08
	23-27	5.46	5.98	0.04	1	0.03
	27-38	5.28	5.71	0.06	0.95	0.02
	38-76	4.7	5.45	0.06	1.13	0.03
	76-120	4.87	5.25	0.06	1.03	0.03
P4	0-5	5.39	5.84	0.06	1.1	0.21
	5-28	5.65	5.84	0.07	1.45	0.23

	28-56	5.56	5.99	0.03	0.98	0.13
	56-90	5.33	5.68	0.07	1.03	0.09
	90-120	4.99	5.54	0.07	1.13	0.06
P5	0-25	5.17	5.57	0.08	1.23	0.14
	25-65	5.45	5.77	0.07	1.45	0.05
	65-120	5.54	5.69	0.07	1.65	0.14
P6	0-10	5.49	5.83	0.03	1.2	0.09
	10-47.	5.54	5.64	0.06	1.58	0.08
	47-88	5.19	5.6	0.03	1.38	0.05
	88-120	5.51	5.73	0.04	1.2	0.03
P7	0-22	5.58	5.53	0.03	1.15	0.13
	22-95	4.74	5.53	0.04	1.43	0.1
	95-120	5.06	5.44	0.05	1.33	0.04

CONCLUSION

Overall findings from this initial study show heterogeneity in soil texture that may influence tree soil matching. Low soil nutrients reserve may also contribute to lower growth but can be corrected through fertilizer addition, if the need arises.

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