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Research Article

Adaptability of some legume trees on quartz tailings of a former tin mining area in Bangka Island, Indonesia

B.H. Narendra*, Pratiwi

Forestry Research and Development Centre, Research, Development, and Innovation Agency, Ministry of Environment and Forestry, Republic of Indonesia, Jalan Gunung Batu no. 5, Bogor 16118, Indonesia

*corresponding author: budihadin@yahoo.co.id

Abstract: Tin mining activities in Bangka Island, besides their important role in contributing to state revenues, also caused damage to the environment, among others in the form of quartz tailings overlay. To rehabilitate this land, in addition to the necessary efforts to improve soil conditions, success is also determined by the selection of appropriate plant species. This study was aimed to determine the adaptability of some legume trees grown on the quartz tailings in land rehabilitation trials in the post tin mining areas of Bangka Island. The legume trees tested were *Calliandra calothyrsus* Meisn., *Caesalpinia sappan* L., *Enterolobium cyclocarpum* (Jacq.) Griseb., *Gliricidia sepium* (Jacq.) Walp., *Delonix regia* (Hook.) Raf., and *Cassia siamea* Lamk. Treatments of growing media applied in the field were medium I (a mixture of 20% organic material, 20% top soil, 1% NPK fertilizer, 5% calcium, and 54% quartz tailings), media II (a mixture of 25%organic material, 25%top soil, 2% NPK fertilizer, 6% calcium, 42% quartz tailings), and media III (a mixture of 30% organic material, 30% top soil, 3% NPK fertilizer, 7% calcium, and 30% quartz tailings). The observation was done by measuring the height and diameter of the stem of the plants, as well as the viability of one year after planting. Analysis of the results of measurements of stem height and diameter showed their diversity. *Enterolobium cyclocarpum* had the largest dimensions, while the lowest was *Caesalpinia sappan*. At the age of one year in the field, *Gliricida sepium* and *Enterolobium cyclocarpum* showed the average ability of the high life of up to 100%, whereas *Calliandra calothyrsus* was totally death. In general, the types of legumes selected in this trial showed good adaptability, except for of *Calliandra calothyrsus*.

Keywords*: adaptation, growth, legumes, quartz tailings, tin mining*

Intoduction

Tin mining activities in Bangka Island besides their important role in contributing to state revenues they also have a negative impact on the environment. Large and small scale tin mining activities have made large area of forest and agricultural lands remain uncovered without proper land reclamation. Top soil that was peeled out during the mining process was not well stored for post mining activities. These conditions resulted in many post mining land areas are covered quartz sand as tin processing waste (Nurcholish et al., 2013).

Quartz tailing has a low pH (4-5). The contents of soil microbes and nutrients are also low due to the loss of top soil layer that leach out the nutrients. These tailings contain very high (over 95%) sand fraction with very low clay and organic matter contents that result in very low buffering capacity of the quartz tailings (Pratiwi et al. 2012). Rehabilitation of post mining land should not rely solely on natural succession process because it takes a very long time and the condition of the land can be further damaged by uncontrolled erosion process. In practice, in addition to the necessary efforts to improve soil conditions, the success of land reclamation is also determined by the selection of appropriate plant species.

Improving soil conditions can be done by providing ameliorant materials such as manure combined with other inorganic materials. At previous studies, aplication of 20% top soil, 20%

organic material 1% NPK fertilizer, and 5% lime (by weight) onto nursing media of quartz tailings significantly improved the growth of plant species of *Eucalyptus urophilla* and *Anthocephalus cadamba* compared to control treatment (Pratiwi et al., 2012). In determining the type of plants, the use of local species combined with other types of plants having the characteristics of fast growth, play a role in improving soil conditions, cover the surface of the soil, and produce biomass, such as plant species of the family of Leguminosae, should be considered.

The use of legume plants in land rehabilitation proved capable of rapid covering of soil surface. Legume plants are also capable of association with *Rhizobium* that can fix nitrogen from the air to enrich soil nutrient. Roots and litters pf legume plants can increase the organic matter content of the soil by acting as green manure or mulch (Narendra and Multikaningsih, 2006). This study was aimed to determine the adaptability of some types of legumes grown on quartz tailings in rehabilitation trial of post tin mining lands in Bangka Island.

Materials and Methods

Planting trial of some types of legume were made using plant material (seeds) which have been planted in 2012. The type of legumes used in ths study were *Calliandra calothyrsus* Meisn., *Caesalpinia sappan* L., *Enterolobium cyclocarpum* (Jacq.) Griseb., *Gliricidia sepium* (Jacq.) Walp., *Delonix regia* (Hook.) Raf., and *Cassia siamea* Lamk.

Planting was made with a completely randomized design. Each planting hole that was made with the size of 40 x 40 x 40 cm, was filled with one of the following media: medium I (a mixture of 20% organic material, 20% top soil, 1% NPK fertilizer, 5% calcium, and 54% quartz tailings), media II (a mixture of 25%organic material, 25%top soil, 2% NPK fertilizer, 6% calcium, 42% quartz tailings), and media III (a mixture of 30% organic material, 30% top soil, 3% NPK fertilizer, 7% calcium, and 30% quartz tailings). Observations that were made at the age of one year after planting included plant height, stem diameter (measured at 10 cm above the soil surface), and ability to live. Statistical analysis was performed to determine the effect of treatments tested against the observed response.

Results and Discussion

The average results of dimensional measurement and the ability to live of the plants studied after one year are presented in Table 1. The ability of plant live is an early feature of the plant's ability to adapt to the environment. *Enterolobium cyclocarpum* had the largest dimensions, while the lowest was *Caesalpinia sappan*. At the age of one year in the field, *Gliricidia sepium* and *Enterolobium cyclocarpum* showed the high ability to live reaching to 100%, whereas *Calliandra calothyrsus* was totally death.

Statistical analysis showed the effect of treatments on the response observed mainly in stem diameter. Duncan test results showed significant differences among treatments in stem diameter, whereas the difference in plant height was only found in *Gliricidia sepium*. Treatment addition of planting medium applied so far did not show the same trend on each type of plant. The best growth of *Gliricidia sepium* and *Caesalpinia sappan* was observed on medium III, while that of *Cassia siamea* and *Delonix regia* was observed on medium I.

To determine the growth and abaility to live of each plant species in each treatment, further observations are still required in subsequent years. The legume types selected in this trial are well known to have functions in soil conservation nd soil fertility improvement. In the rehabilitation of open land, the use of legumes were able to rapidly cover the soil surface so that serves as a protective ground of raindrops and runoff. In addition, the ability to add nitrogen soil is a key advantage of the use of legumes. Sullivan (2003) suggested that the use of plant species of legumes can replace the use of nitrogen fertilizers amounted to 72-190 kg / ha. In this study, *Enterolobium cyclocarpum* and *Gliricida sepium* were able to grow and showed very good adaptability in quartz tailings. *Enterolobium cyclocarpum* can reach a height of 1.27 m with a diameter of 1.6 cm.

Sari (2011) reported that the height of *Enterolobium cyclocarpum* grown on quartz tailings of Bangka Island using 2 kg compost treatment plus 200 g of urea per planting hole reached 1.38 cm with stem diameter of 4.3 cm after 15 months. These values are still far behind when compared with the growth *Enterolobium cyclocarpum* on normal lands. With fertile soil conditions, the height of *Enterolobium cyclocarpum* can reach 7 m with stem diameter of up to 7 cm. As for *Enterolobium cyclocarpum*, *Gliricidia sepium* showed better plant height and stem diameter at medium treatments compared with control. Medium III that contained greater manure, top soil, NPK fertilizer and lime more than medium I or medium II, resulted in high values, although the difference was statistically not significant, particularly for plant height variable of *Caesalpinia sappan*.

Table 1. Plant height, plant diameter, and abality of the plant to live after one year

Legumes	Treatments	Plant height (cm)	Plant Diameter (mm)	Abilty to live (%)
Enterolobium cyclocarpum	Medium I	124.6 a	13.0 bc	88.9
	Medium II	125.2 a	14.0 ab	94.4
	Medium III	127.2 a	16.1 a	100
	Control	112.1 a	10.4 c	77.8
Gliricidia sepium	Medium I	61.9 b	10.2 bc	100
	Medium II	82.9 a	12.2 b	94.4
	Medium III	92.6 a	16.3 a	100
	Control	60.4 b	8.6 c	88.9
Caesalpinia sappan	Medium I	20.8 a	5.2 a	72.2
	Medium II	24.1 a	3.8 a	94.4
	Medium III	23.3 a	5.4 a	50.0
	Control	23.8 a	4.5 a	33.3
Delonix regia	Medium I	82.3 a	11.7 ab	72.2
	Medium II	73.4 a	10.0 ab	55.6
	Medium III	67.5 a	12.3 a	72.2
	Control	55.7 a	8.4 b	38.9
Cassia siamea	Medium I	67.8 a	6.2 ab	50.0
	Medium II	49.9 a	4.4 b	50.0
	Medium III	44.7 a	7.2 a	72.2
	Control	57.0 a	4.8 ab	22.2

Remarks: medium I (a mixture of 20% organic material, 20% top soil, 1% NPK fertilizer, 5% calcium, and 54% quartz tailings), media II (a mixture of 25% organic material, 25%top soil, 2% NPK fertilizer, 6% calcium, 42% quartz tailings), and media III (a mixture of 30% organic material, 30% top soil, 3% NPK fertilizer, 7% calcium, and 30% quartz tailings). Numbers followed by similar letters are sinificantly different at 95%.

Planting of *Gliricidia sepium* in large scale can improve soil conditions as each gliricidia tree is able to fix as much as 14.10 - 14.42 g N equivalent to 131-144kg N / ha / year (Gunaratne et al., 1998).*Gliricidia* leaves are rich in nitrogen and are good to be used either as mulch or green manure because they can increase nutrients, control weeds, retain moisture and reduce temperature of the soil. Moreover, the existence of *Gliricidia* in an area can prevent fungi and insect attacks due to the content of certain chemical compounds in the leaves of *Gliricidia* (Glover, 2004).

At a later stage, to enhance the growth of the plants, adding organic and inorganic fertilizers need to be done regularly. Provision of NPK fertilizer should be done gradually, not just one at the start in large numbers because it would be risky dissolved during the rainy season (Asma et al., 2010). Addition of organic matter through manure application on a regular basis, can improve physical, chemical and biological soil fertility. Soil structure will be good, water storability and CEC also increase, so the buffering capacity of the nutrients also increase. With good growing conditions, diversity of microorganisms in the soil will also increase, thus helping the decomposition of organic matter in the medium.

Giving top soil in the treatment medium is also very useful because it still contains relatively high nutrients compared to the quartz tailings. Thus organic matter (compost) and top soil can increase soil fertility, resulting in better plant growth (Pratiwi et al., 2012).

References

Asma, I.W.,Rasidah, K.W., Rosenani, A.B., Aminuddin, H. and.Rozita, A. 2011. Effects of mulching and fertilizer on nutrient dynamics of sand tailings grown with *Acacia* hybrid seedlings. *Journal of Tropical Forest Science* 23(4):440-452.

Glover, N. 2004. A quick guide to useful nitrogen fixing trees from around the world. Website www.factnet.winrock.org. Accessed 30 September 2015.

Gunaratne, W.D.L**.**, Heenkenda, A.P., Premakumara, K.V.S. and Bandara, W.M.S. 1998. Screening of woody and shrub legumes for agro-forestry systems based on biomass production, N yield and biological N_2 fixing capacity. Forestry and Environment Symposium, Sri Lanka.

Narendra, B.H. dan Multikaningsih, E. 2006. Pengaruh penanaman beberapa jenis legum terhadap kondisi tanah pada areal bekas penambangan batu apung.

Info Hutan volume 3. number 3. Puslitbang Hutan dan Konservasi Alam. Bogor.

Nurcholis, M., Wijayani, A. dan Widodo, A. 2013. Clay and organic matter application on the coarse quartz tailing material and the sorghum growth on the post tin mining at Bangka Island. *Journal of Degraded and Mining Lands Management* Vol.1(1):27-32

Pratiwi, Santoso, E. dan Turjaman, M. 2012. Penentuan dosis bahan pembenah tanah (*ameliorant*) untuk perbaikan tanah dari *tailing* kuarsa sebagai Medium tumbuh tanaman hutan. *Jurnal Penelitian Hutan dan Konservasi Alam* 9 (2):163-174.

Sari, P.M. 2011. Keberhasilan revegetasi pada lahan tailing pasir pasca penambangan timah dengan tanaman sengon buto di PT.Koba Tin. Laporan Kuliah Lapangan. Jurusan Agroteknologi, Fakultas Pertanian, Perikanan dan Biologi, Universitas Bangka Belitung.

Sullivan, P. 2003. Overview of Cover Crops and Green Manures. Website http://www.attra.ncat.org. Accessed 30 September 2015.