Proceedings

PROCEEDINGS OF THE 10TH INTERNATIONAL CONFERENCE OF THE EAST AND SOUTHEAST ASIA FEDERATION OF SOIL SCIENCE SOCIETIES

Soil, A Precious Natural Resource: Agricultural Ecosystems, Environmental Health & Climate Change

October 10 – 13
Cinnamon Lakeside Hotel
Colombo, Sri Lanka

ESAFS
...UTHEAST ASIA FEDERATION OF SOIL SCIENCE SOCIETIES
...and Southeast Federation
...f Soil Science Societies

SSSL
...cience Society of Sri Lanka

Department of Agriculture

FAO Regional office for Asia and the Pacific

Department of Export Agriculture Sri Lanka

University of Peradeniya

NUTRIENT CYCLE IN ACACIA CRASSICARPA PLANTATION ON DEEP TROPICAL PEATLAND AT BUKITBATU, BENGKALIS, INDONESIA

Suwardi[1]*, G. Djajakirana[1], B. Sumawinata[1], DPT. Baskoro[1], C. Munoz[2] and R. Hatano[3]
[1] Department of Soil Science and Land Resources, Faculty of Agriculture, Bogor Agricultural University
[2] Sinar Mas Forestry
[3] Faculty of Agriculture, Hokkaido University
* Coprresponding author: suwardi_bogor@yahoo.com

Introduction

Development of annual crops on tropical peatland in Indonesia in most cases eventually ended up in failures and has resulted in serious environmental deterioration, including the latest huge one million-hectare rice project in Central Kalimantan. The causes of failures were widely discussed and primarily failures were attributed to land and soil characteristics for crops cultivation. Among others, flooding, peat subsidence, and problems associated with low decomposed peat material in deep peat (ombrogenous peat) and nutrient deficiencies were mentioned.

Mindful of the problems and environmental impact that could happen, utilization of tropical peatland for perennial crop production poses both economic and environmental challenges (Darmawan et al., 2011). It is too early to say however that any utilization of peatland in Indonesia will drastically lead to environmental deterioration and that it is not beneficial for the country's development. There are strong indications that some utilization for forest and oil palm plantations appear to be wise choices.

Bukitbatu is one of Indonesian peat areas in Sumatra Island dominated by deep peat having more than 10 m depth. The peatland now are used for forest plantation by cultivation of *Acacia crassicarpa* as raw material of pulp industry. Although the *A. crasscicarpa* is only fertilized in the first year and with a very low rate, the growth of plant is very fast. The objective of this research is to study the nutrients cycle of the *A. crassicarpa* planted in peatland.

Materials and Methods

The research was conducted at peat swamp area in the working area of Sinar Mas Plantation at Bukitbatu, Bengkalis Regency, Riau Province, Indonesia. The area is now planted with *A. crassicarpa*. The acacia plants usually are harvested after 5 years and planted again for the next cycle. Soil samples were collected for chemical and physical analysis. For soil chemical analysis, the samples were taken compositely from the upper 10 cm layer for pH, macro and micro nutrients. The samples for bulk density were taken by using box sampler with a size of 30 cm x 30 cm x 30 cm.

Biomass measurement of standing *A. crassicarpa* plants of different ages were conducted by cutting down sample trees and weighting part of the trees. The trees were sampled within a plot of 20 m x 20 m. Some 6-7 plants of each age were sampled. The amount of litter fall down to the ground was measured by collecting the litter using a net of 1 m x 1 m size placed on about 75 cm from the ground under 3 years old of acacia trees. Each month the litter fall trapped in the net was weighted for calculating the total litter fall added to the soil. The macro and micro nutrients in the litter fall were analyzed for calculating nutrient cycle. In a separate research, rate of litter decomposition was measured by using litter bag containing litter fall laid in plantation floor. Some 48 bags containing 20 g of litter fall were laid on the surface and sub surface of the top soil with two replications. Each month , 4 bags containing litter fall were taken from the surface and subsurface soil for weighing the rest of litter fall in the litter bag.

Results and Discussion

Soil chemical analyses showed that peat soil has very low pH ranged from 3.2 to 3.5 and contained very poor in macronutrients and micronutrients. The bulk density ranged from 0.15-0.17 g/cm^3 in oxidized surface layer and 0.08-0.10 g/cm^3 under submerged condition. Those soil properties showed that the fertility of peat was very low. Therefore, the utilization of peatland for perennial crops which need high fertility will run into some problems. Furthermore, intensive land cultivation that must be done for the annual crops will accelerate land to change especially with peat decomposition. On the contrary, perennial crops such as *A. crassicarpa* can grow well and gave good production. To date, *A. crassicarpa* at Bukitbatu has entered to the second cycle. This fact showed that *A. crassicarpa* has proven as perennial crop that gave minimal land changes and demonstrated as very adaptive tree to grow on deep peat areas.

A. crassicarpa grows very fast (Table 1). The plant is a legume, requiring N, P, K fertilization and cultivation only in the first year. This statement is supported by the fact that in one year after planting, the height of plant reached 6 m with diameter of 5.5 cm. The plant usually was harvested 5 years after planting with the height reaching 30 m and the diameter of 25 cm. With this growth characteristic, *A. crassicarpa* is classified as fast growing plant and adaptive to deep peat.

Table 1. Average growth parameter of *A. crassicarpa* during 5 years (weights on oven dry weight basis).

Age (Year)	Diameter (cm)	Height (m)	Root (kg)	Stump (kg)	Stem (kg)	Branch (kg)	Leaf (kg)	Total (kg)
1.0	5.5	6.0	0.8	1.0	2.5	2.6	3.8	[illegible]
2.0	11.0	12.0	2.9	3.3	16.0	6.7	4.8	33.6
3.0	15.0	16.5	7.0	8.0	40.4	12.6	4.9	72.9
4.0	19.0	22.5	15.2	17.3	78.3	26.8	6.9	144.5
5.0	25.0	30.0	35.3	40.1	144.4	65.4	26.5	311.8

Based on litter fall measurements, during 8 months of observations, there has been 611.12 g/m^2 of dry weight litter fall or equal to about 9.2 ton/ha/year oven dry weight. Decomposition of litter fall of *A. crassicarpa* was very fast, 60% litter fall from *A. crassicarpa* was decomposed in 3 months whereas litter fall from natural forest in the same period only decomposed 40%. From macronutrient analysis of litter fall the amount of potential macro nutrients released from litter fall to soil could be estimated (Table 2). The highest nutrient released from litter fall was nitrogen. In one ha, the nitrogen content in litter fall was 271 kg/ha/year or equivalent to 602 kg urea/ha/year. The very high number of nitrogen content in litter fall was attributable to the fact that acacia is a leguminous plant having dense lateral roots rich in nodules. The other nutrients (P, K, Ca, Mg and S) will cycle from litter fall, released to soil and taken again by plants without a significant increase. These nutrients become available for growing plants after the litter fall is decomposed by microorganisms. Based on litter fall decomposition in the litter bag, acacia leaf decomposed very fast indicating that acacia leaf is good composting material.

Table 2. Content of macronutrients in litter fall and equivalent macronutrients for one ha per year.

Litter Fall from Acacia	N	P	K	Ca	Mg	S
Content of macro nutrients (%)	2.95	0.15	1.76	0.91	0.36	0.28
Equivalent of macro nutrients based on the amount of 9.2 ton litter fall/ha/year (kg/ha/year)	271.1	13.8	161.9	83.7	33.1	25.8

The nutrients releases from litter fall decomposition are used for enriching soils and growing of acacia plant. From the above results, *A. crassicarpa* shows success as a plantation crop that can sustain growth on peatland due to the nutrient cycle produced by the plant itself with low fertilizer input.

Conclusions

Peatland has low pH and are poor in macro and micro nutrients. However, *A. crassicarpa* can adapt and grow in peat soils due to the plant having lateral roots rich in nodules. Measurement of litter fall using nets showed that one hectare of Acacia plantation aged 3 years produced about 9.2 tons/ha/year oven dry weight of litter fall or equivalent to 271 kg N ha/year. After 3 months some 60% of litter fall have been decomposed.

Acknowledgments

We thank Sinar Mas Groups for their financial support for this research and permission for using Bukitbatu Acacia plantation for location of this research.

References

Darmawan, B. Sumawinata, G. Djajakirana, Sudarsono, and B. Mulyanto. 2011. Conceptual views on the methodology of researching nature and change of tropical peatland toward proper management and policy. *In* Suwardi et al. (Eds.). Proceedings of Palangkaraya International Symposium & Workshop on Tropical Peatland, Palangkaraya-Indonesia, June 10-11, 2010. p. 1-12.