

Entisol land characteristics with and without cover crop (*Mucuna bracteata*) on rubber plantation

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Abstract. Optimal nutrient delivery is one way to improve the quality and quantity of crop production. This is because the crops needs for nutrient is quite high, while the soil capacity in providing nutrients is limited. In addition to fertilization, nutrients can be given in the form of added organic material or planted as cover crop. The research took place from April to August 2016 in Bandar Pinang, Bandar Sumatera Indonesia Ltd. (SIPEF Group) plantation, with survey method. Soil samples were taken based on: Topography (flat and slope 15-30%), cover crop (with or without *Mucuna bracteata*) and plant age (seedling periods 1, 2 and 3). The soil sample is taken composite by zig zag method. The observed parameters were organic matter, N total, soil texture, bulk density and infiltration rate. *Mucuna bracteata* planting increased the contain of soil organic matter by 30.43% in flat area and 53.33% in hilly area, amount of N total soil by 27.27% in flat area and 7.69% at hilly area, bulk density 3.73 % In flat area and 0.41% in hilly area, soil infiltration by 48.88% with sandy clay dominant soil texture.

1. Introduction

Entisol has a loose consistency, low aggregation rate, is sensitive to erosion and low availability of nutrient content. The soil potential which derived from this volcanic ash is rich in nutrients but not available yet, corrosion will be accelerated when there is sufficient organic matter activity as a provider of organic acids [1]

In the management of rubber plantations, the policy to plant legume cover crop is carried out on young rubber cultivation. The planting of legume cover crop are aimed to overcome surface erosion and soil nutrient leaching, enrich organic materials, enrich soil N-nutrients, improve soil structure, maintain soil moisture and suppress weed growth.

The covering rate of *Mucuna bracteata* can reach 2-3 m² in a month. The plantations area will perfectly covered by entering the 2nd year of planting, with 40 to 100 cm vegetation thickness. In the 3rd year the dry matter produced can reach 8-10 tons ha⁻¹, while other legume cover crop are 4.4 tons ha⁻¹. Besides biomass, soil fertility rates also increase because these legume cover crop also have root nodules that can fixate free nitrogen from the air into the NH₄⁺ form that is available for plants. [2]

Seeing the rapid used of *Mucuna bracteata* as cover crops on various land uses, hence this research is done to know the role of *Mucuna bracteata* at rubber plantation phase of immature plant in improving the properties of Entisol in flat and slope land topography.

2. Research Methods

The research was conducted in Bandar Pinang, Bandar Sumatera Indonesia Inc. (SIPEF Group) plantation from April to August 2016. This research used survey method; the soil was taken



compositely at a depth of 20 cm in accordance with the specified sampling point. The soil sampling point was taken based on: topography (flat and slope), cover crop (with and without *Mucuna bracteata*) and plant age (Seedling period 1, 2 and 3).

The soil samples were dried, sieved with screen of 10 mesh, then analyzed in the laboratory. The observed parameters were; organic matter (*Walkley & Black* methode), N-total level (*Kjeldahl* methode), soil texture (hydrometer methode), Bulk Density (BD) (gravimetry methode) and soil infiltration (infiltrometer)

Table 1. Observation results of organic matter content, N-total, texture, bulk density and soil infiltration

No	Treatment	Organic matter (%)	N-total (%)	Texture	Bulk density (gr cm ⁻³)	Infiltration (mm Hour ⁻¹)
1	Flat & without MB Seedling Period 1	2.08	0.16	sandy clay loam	1.30	142.2
2	Flat & without MB Seedling Period 2	2.08	0.09	sandy clay loam	1.27	40.8
3	Flat & without MB Seedling Period 3	1.77	0.08	sandy clay loam	1.21	31.8
4	Flat & with MB Seedling Period 1	2.58	0.15	sandy clay loam	1.27	75.0
5	Flat & with MB Seedling Period 2	2.82	0.14	sandy clay loam	1.20	24.0
6	Flat & with MB Seedling Period 3	2.35	0.13	sandy clay loam	1.17	10.8
7	Slop & without MB Seedling Period 1	0.97	0.07	sandy clay loam	1.25	55.2
8	Slop & without MB Seedling Period 2	1.94	0.09	sandy clay loam	1.19	34.8
9	Slop & without MB Seedling Period 3	1.41	0.10	sandy clay loam	1.25	62.4
10	Slop & with MB Seedling Period 1	1.98	0.10	sandy loam	1.27	60.0
11	Slop & with MB Seedling Period 2	1.98	0.07	sandy clay loam	1.25	75.0
12	Slop & with MB Seedling Period 3	2.68	0.11	sandy clay	1.16	199.8

3. Results and Discussions

3.1 Organic Matter

Organic materials play an important role in building sustainable agriculture and preserving nature. Organic materials can improve the physical, chemical and biological properties of soil.

In this research, organic matter was derived from leaf litter produced by *Mucuna bracteata*. Average soil organic matter content in flat area without *Mucuna bracteata* is 1.98% and with *Mucuna bracteata* is 2.58%. Average soil organic matter content in slop area without *Mucuna bracteata* is 1.44%, and with *Mucuna bracteata* is 2.22%. In flat area planted with *Mucuna bracteata* increased the organic matter content by 30.43% while in slope area by 53.53%.

Mucuna bracteata has higher organic content than other beans for cover crop. *Mucuna bracteata* planting is able to contribute wet leaf litter up to 5.23 ton ha⁻¹, much higher compared to conventional LCC with only 4.41 ton ha⁻¹ [3]

3.2 N-total Content

Nitrogen nutrient is one of the essential elements needed by plants. Nitrogen can be obtained from the air through N fixation with the help of microorganisms.

The research results showed; the average of N total on flat area without *Mucuna bracteata* is 0.11%, with *Mucuna bracteata* is 0.14%. The average of N total on slop area without *Mucuna bracteata* is 0.08%, with *Mucuna bracteata* is 0.09%. In flat area planted with *Mucuna bracteata*, soil N-total content increased by 27.27% while in the slope area increased by 7.69%.

Organic matter is the main source of Nitrogen in soil [4]. *Mucuna bracteata* is a cover crop which produces quite a lot leaf litter so that it will directly affect the levels of Nitrogen in the soil apart from the influence of *Rhizobium* bacteria found in the root nodule. Entisol chemical property in organic farming system shows that entisol which cultivated with organic crops have a higher of N-total content, organic farming system obviously improve soil chemical properties [5].

3.3 Soil Texture

The relative size of soil particles is expressed in terms of texture, which refers to the fineness or roughness of the soil. The rate and extent of various important physical and chemical reactions in plant growth is governed by texture, since this texture determines the number of surfaces at which the reaction occurs [6]. Soil texture contributes to soil structure, water system, air system and soil temperature.

Soil texture at Bandar Pinang Estate is dominant with sandy clay loam, other than that is also found sandy loam and sandy clay soil texture. In accordance with the type of soil at the location of research i.e. Entisol, one of its characteristics is rough-textured. Rough textured soil is difficult to retain water, consequently the rate of soil infiltration is relatively fast, and this is evidenced from the observation of infiltration which on average is quite fast.

3.4 Bulk Density

Bulk density is an indication of soil density. The denser a soil is, the higher its bulk density, which means it is increasingly difficult to continue the water or the plants root to penetrate. Bulk density is important to calculate the need for fertilizer or water for each hectare of land based on soil weight/hectare [4].

The average level of bulk density on flat area without *Mucuna bracteata* is 1.26 gr cm^{-3} and with *Mucuna bracteata* is 1.21 gr cm^{-3} . The average level of bulk density on slope area without *Mucuna bracteata* is 1.23 gr cm^{-3} and with *Mucuna bracteata* is 1.22 gr cm^{-3} . In flat area planted with *Mucuna bracteata* can fix bulk density by 3.73% while on slope area by 0.41%. The improvement of bulk density on the slope area planted with *Mucuna bracteata* tends to be smaller due to the surface flow that transports soil particles.

The ideal of bulk density level in soil is around $1.1 - 1.6 \text{ gr/cm}^3$ [4]. The research results obtained, showed that bulk density on each sample of observation is between $1.1 - 1.3 \text{ gr/cm}^3$. This result illustrated that the soil did not experience compaction, thus the development of the rubber plants roots and the entry of water into the soil runs well.

Previous research on palm oil, the planting of *Mucuna bracteata* in palm oil plantations was able to improve some physical and chemical soil properties such as fixing bulk density by 12.64% on flat area and 6.04% on slope area [7]

3.5 Infiltration

One of the important soil physical properties to be known is the infiltration rate, which is the maximum velocity of water entering vertically into the soil.

Average infiltration rate in flat area without *Mucuna bracteata* is $71.6 \text{ cm hour}^{-1}$, mean while in area planted with *Mucuna bracteata* is $36.6 \text{ cm hour}^{-1}$. In a flat area planted with *Mucuna bracteata* can improve the soil infiltration rate by 48.8%. The average infiltration rate in the slope area without *Mucuna bracteata* is $50.8 \text{ cm hour}^{-1}$, mean while with *Mucuna bracteata* is $111.6 \text{ cm hour}^{-1}$. Soil infiltration class is belonged to the very quick class; this is influenced by sand-dominated soil particles.

Cover crops can neutralize the destructive power of raindrops and suppress runoff; which can inhibit erosion and nutrient leaching. This is reflected by the positive effect of cover crops on soil physical properties [8]

4. Conclusions

The leaf litter produced by *Mucuna bracteata* is the main important source in improving the entisol properties through the formation of organic matter. *Mucuna bracteata* planting on rubber plantation is able to repair around 3.74% of bulk density in flat area and 0.41% in slope area, 48.88% of soil infiltration in flat area, the content of soil organic matter around 30.43% in flat area and 53.33% in slope area, and soil nitrogen content around 27.27% in flat area and 7.69% in slope area.

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