# SOILS 2019

## PROCEEDINGS OF THE SOIL SCIENCE CONFERENCE OF MALAYSIA 2019

## Sustainable Soil Management and Conservation

16-18 APRIL 2019

Equatorial Hotel, Melaka


**EDITORS**

Rosazlin Abdullah
Christopher Teh Boon Sung
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PERSATUAN SAINS TANAH MALAYSIA
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**PROCEEDING BOOK**

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# *MUCUNA BRACTEATA*: YIELD HARVESTED AND THE EFFECT OF HARVESTING FREQUENCIES ON THE SOIL PROPERTIES UNDER MATURE OIL PALM (KOMBOK ESTATE)

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## INTRODUCTION

*Mucuna bracteata* was reported to be 'outstanding' legume cover for soil water and soil conservation than to the other leguminous cover crops (LCC) such as Pueraria javanica (PJ), Colopogonium muconoides (CM), Colopogonium caereleum (CC), Centrosoma pubescenes (CP) etc. due to its vigorous growth, tolerate to shade and drought as well as vulnerable to diseases and pests. Since the legume was introduced in Malaysia in 1991 (Mathews, 1998), the establishment of the cover under oil palm all over Malaysia was tremendous especially at the immature areas where there are new planting or replanting, sloppy as well as hilly areas (Ng et al., 2006; Lee et al., 2005; Mathews and Leong, 2000). The huge amount of the resources

Cutting or harvesting frequency on the other energy crops, legumes, grasses, tubers for biomass feedstocks have been well reported. The yield after being cutting or harvesting for energy, animal feeds, chemical precursors and other value added products were also well documented (Basra et al., 2015; Hue et al., 2012; Rengsirikul et al., 2011; Adjolohoun et al., 2008; Terrill et al., 2003; Ella et al., 1991). There were not much details on the harvesting or harvesting frequency on Mucuna bracteata, instead of the roles for soil water and soil conservation (Ng et al., 2006; Lee et al., 2005; Mathews and Leong, 2000). One of the objective for this study was to evaluate the implication of harvesting frequency after several times on Mucuna bracteata on the soil physical and chemical properties.

## MATERIALS AND METHODS

The research was conducted at the Kombok Estate, Rantau, Negeri Sembilan (2.6216°N 101.9836°E) on the Durian Series soil. The maturity of the estate was 8 – 10 years-old. Mucuna bracteata was being harvested according to the time frames in once after two (HF 2), four (HF 4), six (HF 6) and twelve months (HF 12). The harvesting was started at month 0 (initial harvest) until 24 months within 1 m by 1 m areas with four replication. Meanwhile, the control/ no harvest (HF 0) was replication was harvested at month 0 and month 24 only. The aboveground (leaf and stolon) production was determined by the accumulation of Mucuna bracteata's dry weight after several harvesting frequencies. In each of the harvesting times, soil are sampled at two different depths (0 – 15 and 15 – 30 cm depths) by using the Core Method (replications similarly to harvested Mucuna bracteata). The soil was then analyzed physically and chemically with the followings methodologies (Table 1). Initial properties of the soil was determined for comparison at month 24.

**Table 1**: Methodologies applied to determine physical and chemical properties

| | No. | Property | Methodology applied |
|---|---|---|---|
| *Physical* | 1. | *Texture* | *Pipet Method* |
| | 2. | *Bulk density (Mg $kg^{-1}$)* | *Core Method* |
| | 3. | *Water content (%)* | *Core Method* |
| | 4. | *Porosity (%)* | *Core Method* |
| | 5. | *Stability (%)* | *Wet Sieving* |
| | | *Mean width diameter (mm)* | *Dry Sieving* |
| *Chemical* | 1. | *pH ($H_2O$)* | *Soil water ratio, 1 : 2.5 (Mc Lean, 1982) and analyzed by MeterLab@PHM standard pH meter.* |
| | 2. | *Cation Exchange capacity (CEC) ($cmol_+$ $kg^{-1}$)* | *Leaching Method (Thomas, 1982) and the extractant was analyzed by PerkinElmer Atomic Absorption Spectrophotometer PinAAcle 900T.* |
| | 3. | *Total C and N (%)* | *Analyzed by Carbon/Nitrogen/Sulphur TruMac Determinator Version 1.1x.* |
| | 4. | *Available P (ppm)* | *Bray and Kurtz no. 2 extracting solution (Olsen and Sommers, 1982) and the extractant was analyzed by XYZ Auto Sampler ASX – 500 Series.* |
| | 5. | *Available K ($cmol_+$ $kg^{-1}$)* | *Leaching Method (Thomas, 1982) and the extractant was analyzed by XYZ Auto Sampler ASX – 500 Series.* |
| | 6. | *Available Ca and Mg ($cmol_+$ $kg^{-1}$)* | *Leaching Method (Thomas, 1982) and the extractant was analyzed by PerkinElmer Atomic Absorption Spectrophotometer PinAAcle 900T.* |

*Source: Teh and Jamal (2006)*

## RESULTS AND DISCUSSION

After several harvesting frequencies (at month 24), the aboveground of *Mucuna bracteta* yielded about 4 to 17 t $ha^{-1}$ $yr^{-1}$. Excluding control/no harvest (HF 0), the highest yield was HF 2 (17 t $ha^{-1}$ $yr^{-1}$) followed by HF 4 (14 t $ha^{-1}$ $yr^{-1}$), HF 6 (10 t $ha^{-1}$ $yr^{-1}$) and HF 12(4 t $ha^{-1}$ $yr^{-1}$). However, it was observed that harvesting frequencies not affected most of the soil physical and chemical properties studied. The harvesting frequency was observed affected on the soil bulk density, soil aggregate stability as well as soil total C. This occurrence probably related to interaction among harvesting frequencies with times and depths (as shown in table 2).

**Table 2**: Soil physical and chemical properties in mature area after several harvesting frequencies within 24 months.

| *Physical properties* | *HF x T x D* | *HF x D* | *HF x T* | *HF* |
|---|---|---|---|---|
| *Soil bulk density (Mg $m^{-3}$)* | *ns* | *ns* | *ns* | * |
| *Soil aggregate stability (%)* | *** | *ns* | * | *** |
| *Chemical properties* | *HF x T x D* | *HF x D* | *HF x T* | *HF* |
| *Soil total C (g $kg^{-1}$)* | *ns* | *ns* | *** | * |

Notes: HF – harvesting frequencies and T – time (month).*P < 0.10, **P < 0.05, ***P < 0.01 and ns – not significant (P > 0.10).

There were significant effect on the properties mentioned above when related to harvesting and soil depths as indicated in figure 1. At the different depths, after harvesting the soil bulk density was decreased via versa the soil aggregate stability increased for both depths. Normally if the bulk density decreased the stability of the soil also decreased. However, the stability was increased probably pertaining to the interaction of polycationic bridging in which the repulsive forces between negatively charged of the clay and / or SOC. Aggregates containing polyvalent cations ($Ca^{2+}$, $Al^{3+}$ and $Fe^{3+}$) are reported resistant to slaking (Tisdall, 1996). The CEC and surface area of clay minerals, SOC and other soil properties interact to form intraparticle interactions that influence dispersivity (Nelson et al., 1999). Findings in this study showed that the soil total C was decreased at all harvesting frequencies and at 0 -15 cm depths (Figure 1) but not the 15 – 30 cm depth. Probably this was cross related to some physical aspects of the soils (soil pore sizes, soil degradation etc.) as well as soils macro and micro flora which was not study in this research.

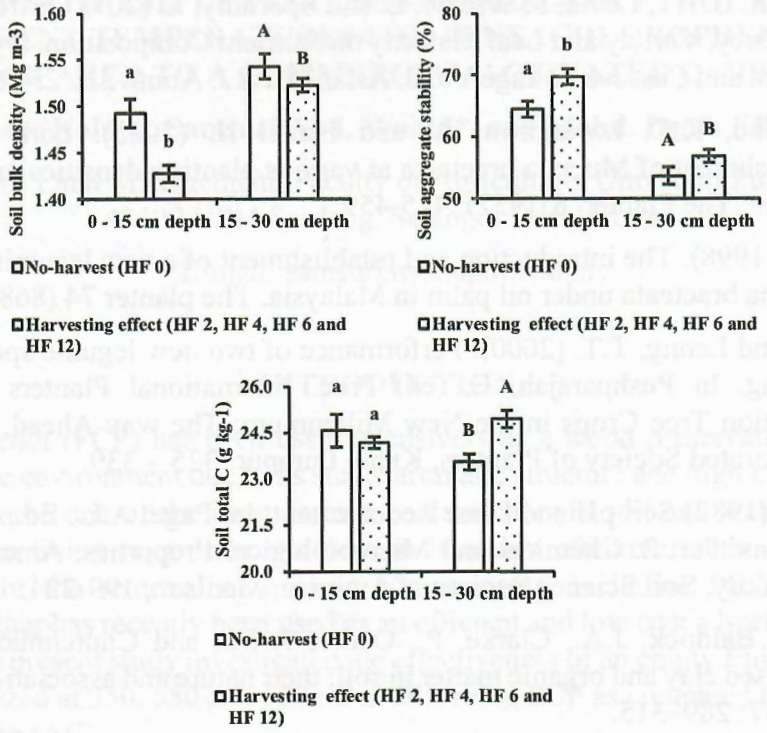


**Figure 1**: Mature area (Kombok Estate) at month 24: Mean (± s.e.) soil bulk density (Mg $m^{-3}$), soil aggregate stability (%) and soil total C (g $kg^{-1}$) across two different depths for a) 0 – 15 cm and 15 – 30 cm after several different harvesting frequencies at month 24. Note: HF **n** is the harvesting frequency for **n** = 0, 2, 4, 6,..12 months.

## CONCLUSION

The more frequent Mucuna bracteata was harvested the more aboveground were yielded (excluded no-harvest/control (HF 0)). Harvesting frequency was observed not much affected on the physical and chemical properties of the soil. Harvesting and depths factors were the main factors that affected soil bulk density, soil aggregate stability and soil total C.

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