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Research Notes

Characterizing Soil Penetration Resistance of Planted Sago Palm (*Metroxylon spp*.) Under Mineral Soils Ecosystem

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Abstract: In-situ soil assessment such as field soil compaction can often be a helpful approach in help determining soil suitability for certain crops. In this study, an assessment was conducted to characterize the Soil Penetration Resistance (SPR) in planted sago palm (Metroxylon spp.) plantation at different growth of rosette and trunking stages under mineral soils ecosystem. SPR in-situ assessment would provide a beneficial guideline and site indicator in determining land suitability before establishing sago plantations, especially on mineral soils. The study was conducted in Mukah, Sarawak, with two study sites at Oya and Talau. The growth stage of sago palm at Oya and Talau site were at the rosette and trunking stage, respectively. The soil types at both study sites consisted of Gley soils (clayey) with significant mineral development at the subsoil horizon. SPR measurements were taken using a Hasegawa-type cone penetrometer. Soil compaction in SSSED Oya was more compact than Talau river research station from shallow depth to subsurface soils. SPR at SSSED Oya ranged between 7.5 to 46.8 J cm-^{1,} while Talau river research station ranged between 1.9 J cm^{-1} to 11.1 J cm^{-1}. Although there was a significant difference between the growth stage of 0-20 cm and 80-100 cm soils depths, both SSSED Oya and Talau river research station are considered suitable areas for sago palm plantations. Using a practical and convenient approach in assessing soil suitability for sago cultivation, SPR assessment to identify potential areas for the establishment of sago cultivation area can be the fundamental tools for landowners in preparing their land for future cultivation.

Keywords: Soil Penetration Resistance, *Metroxylon spp.*, Mineral Soil

Introduction

Sago palm (*Metroxylon* spp.) brings many economic and ecosystem services secondary to oil palm; thus, it has the potential to be a crop that deserves prompt attention. The sago palm industry in Sarawak has become one of the important industries contributing to export revenue for sago-related initiatives in Malaysia (Mohamad Naim *et al*., 2016; Bujang, 2018). Mainly, it was found in the wild, semi-wild, or cultivated by smallholders along the coastal belt, low-lying river areas of the region, including peat swamps. There are two types of sago palms commonly found in Sarawak: The smooth sheathed (*Metroxylon sagu*) and spiny sheathed (*Metroxylon rumpii*). According to Tie *et al*. (1991), the main areas of sago cultivation in Sarawak were mainly located at Oya-Dalat and Mukah region. Since 1992, the total area covered with sago palm in Sarawak has expanded due to the introduction of estate sago plantations by the Sarawak State Government (Karim *et al*., 2008). In achieving sustainable substantial

yield production, good agriculture management practices must be done simultaneously from the land cleaning stages until harvesting stages (Omori *et al*., 2002; Pei-Lang *et al*., 2006; Jong, 2018).

However, very few studies are available on the management of smallholder farmers' practices in improving sago palm growth with increased starch yield (Khan, 2005; Yong, 2014). The excellent growth performance of crops must start with a suitable planting site, good planting materials and an effective planting system (Bujang, 2018). The challenges in cultivating sago palm in Sarawak on peat soils are the inability of the sago palm to develop trunk, long maturity period, low survival rate, slow growth performance, low starch yield and soil problem (Pei-Lang *et al*., 2006; Khan, 2005; Yong *et al*., 2018). Due to these characteristics, peat swamp is unfavorable for the use of sago palm cultivation due to fewer fertilizers and pesticides being applied (Bujang, 2018).

Several reports discuss the influence of various soil properties in sago palm growth development and production when cultivated under smallholder or commercial scale plantations (Bintoro *et al*. 2018; Okazaki and Sasaki, 2018; Nelsi *et al*., 2021; Uthumporn *et al*., 2014; Yong *et al*., 2018). While in-situ soil assessment such as field soil compaction and other soil physical attributes are often found to be a helpful approach in determining soil suitability for certain crops, information on characterizing the state of soil compactness, especially in sago plantation, is still scarce.

Soil physical properties play a vital role in the growth of plants. Improving the soil fertility of agricultural lands can be done even for a shorter period by adopting various technologies, such as adding amendments, i.e., organic and chemical fertilizers. However, this may not be the case when dealing with limitations due to soil physical properties since improving soil physical properties requires more effort and investment (Sakurai *et al*., 1995). Conventionally, a soil pit will be dug at specific points within a land area when soil physical properties are to be assessed. This allows the field assessor to assess certain soil depth; in most cases, digging soil pits within a land area may cause certain forms of disturbance, especially in land areas that consist of standing vegetation or crops. To properly study the effects of these properties, it is necessary to establish a method that can estimate the soil structure quantitatively with minimal disturbance to the actual soil structure that leads to a more practical diagnosis of the soil condition in the field (Mohamad Jaffar *et al*., 2018).

Considering the statement above, this research note was conducted to characterize the Soil Penetration Resistance (SPR) in planted sago palm at different growth of rosette and trunking stages under mineral soils ecosystem. SPR in-situ assessment would provide a beneficial guideline and site indicator in determining land suitability before establishing sago plantations, especially on mineral soils.

Materials and Methods

Study Area

This study was conducted at the Sago Smallholder Satellite Estate Development (SSSED) Plantation located at Mukah Division, Sarawak. Two study areas were selected for this study, namely, SSSED Oya (N02052'06.9" E111053'49.2") and Talau River Research Station (N02048'59.0" E111054'22.4") as shown in Fig. 1.

The soil types in SSSED Oya and Talau research station consist of Gley soils (clayey). The assessment and sampling were selected based on two different growth stages of sago palm under mineral soils.

Two growth stages of sago palm were selected: Rosette stage (one-year-old) and trunking stage (more than five years old). At SSSED Oya, the sago palm is in the rosette stage, while the Talau River research station is at the trunking stage. In general, land preparation for sago palm plantations included land clearing and bush slashing. Each sago palm was planted in a triangular system with a spacing of 7 × 10 m.

Soil Penetration Resistance Evaluation

A Hasegawa-type penetrometer (Daito Techno Green Co., Tokyo, H-60) was used to estimate soil compaction from surface soils to 100cm depth. The soil compaction at different soil depths was expressed in One Drop Penetrability (ODP), as shown in Fig. 2. The horizontal axis shows the penetrating depth (cm) per one drop of weighing; meanwhile, the vertical axis represents the cumulative depth (cm) (Mohamad Jaffar *et al*., 2018). The degree of soil compaction was classified using the value plotted on the horizontal axis following Sakurai *et al*. (1995).

The Soil Penetration Resistance (SPR) was evaluated using Hasegawa type-cone penetrometer. The soil depth range for each assessment was at a depth of 100cm. The total number of strikes was counted to 20 cm interval depth and SPR was calculated using the following formula:

$$E = M \times G \times H \times C$$