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Study of Some Physical Properties of Soil in Immature Oil Palm Plant at Different Slopes

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ABSTRACT

The physical properties of the soil will influence plant growth and development. This research aims to examine the physical properties of soil in various slope classes of oil palm plantations inPTPN III KebunAekNabara Utara, BilahHulu District, Labuhanbatu Regency. This research uses survey and descriptive methods by analyzing the parameters of the physical properties of the soil, namely:Bulk Density (g/cm3) Total Pore Space (%) Soil Structure, Soil Water Content (%), Soil Texture (%). The tools used are a Global Positioning System (GPS), sample ring, hoe, soil drill, penetrometer, oven, permeameter, dry sieve, wet sieve, and pressure plate apparatus. The materials used are soil samples and work maps. The research results show that several soil physical properties showBulk Density value 1.30 – 1.51 g/cm3, Total Pore Space 0.17-0.58%, water content 0.20-0.27%, while the texture is dominantly clayey, and the structure is dominantly angular blocky. The physical properties of soil require a long time to change, because the physical properties of soil are difficult to change.
Keywords:*Oil Palm, Soil Physical Properties, land slope, TBM*

1. INTRODUCTION

The success of oil palm cultivation is determined by environmental factors, namely soil factors and climate factors. (Krisnohadi 2012) States that land is a component in plantation development, including the development of oil palm plantations. The carrying capacity of land in oil palm plantations is a very important aspect in the development of oil palm cultivation. According to (Rosyidah and Wirosoedarmo 2013) continuous cultivation activities can cause changes in the physical properties of the soil. Land management activities result in changes in soil physical properties, soil chemistry and soil biology. A land is said to be good if it has good physical properties, this is also related to determining good environmental quality. The physical properties of soil generally change along with land management activities. According to (et al. 2017)plantation land management activities such as land clearing, land burning, use of heavy equipment and fertilization activities can affect the physical properties of the soil. Another impact of clearing land for plantations is reducing the organic matter content of the soil. Organic matter plays a very important role in maintaining the physical properties of the soil so that they remain good.Physical characteristics are used to consider and determine agricultural land. The physical properties of the soil affect the availability of water, air, and the availability of plant nutrients so that the physical properties of the soil greatly influence maximum plant productivity.

Soil physical properties are soil properties that can be measured by sight or touch. These characteristics can be expressed on scales such as size, tension or intensity. Each soil has certain physical properties that depend on the nature of each component, the number of components that make up it, and the arrangement of these components. The physical properties of the soil can influence plant growth directly or indirectly (Gusmara et al., 2016). The nature of the soil is very important in supporting the growth and development of plants as well as the physical, biological and chemical properties of the soil. Soil physical properties include soil structure, texture and permeability. Soil properties must be analyzed to support plant productivity and community welfare (Tewu et al., 2016).

The physical properties of soil are closely related to the suitability of the soil for the various land uses expected of the soil. The strength and carrying capacity of drainage as well as the ability to retain nutrients, ease of root penetration, aeration and retention of plant nutrients are closely related to the physical condition of the soil. Soil physical properties include soil texture, soil texture, soil consistency and soil porosity (Meli et al., 2018).

As plantation crops such as oil palm grow, it is thought that they can restore the physical properties of the soil, which is supported by Bahendra (2016), changes in physical properties due to oil palm planting can change as the age of the plant increases. It is important to carry out acstudy of several physical properties of soil planted with oil palm with the aim of knowing the differences in the characteristics of soil physical properties at various dryness for oil palm.

2. MATERIALS AND METHODS

Time and Place

The research was carried out in oil palm plantationsPTPN III KebunAekNabara Utara, BilahHulu District,

LabuhanbatuRegency, North Sumatra with coordinates E : 99°52’30”and N : 2°4’10”with a height of 29 meters above sea level is presented in Figure 1. The soil type at the research location is Inceptisol. Soil sample analysis was carried out at the Integrated Science Laboratory, Faculty of Science and Technology, Labuhanbatu University and the Socfindo Seed Production and Laboratories (SSPL) Laboratory. The research lasted for 4 months, namely from October 2023 to January 2024.

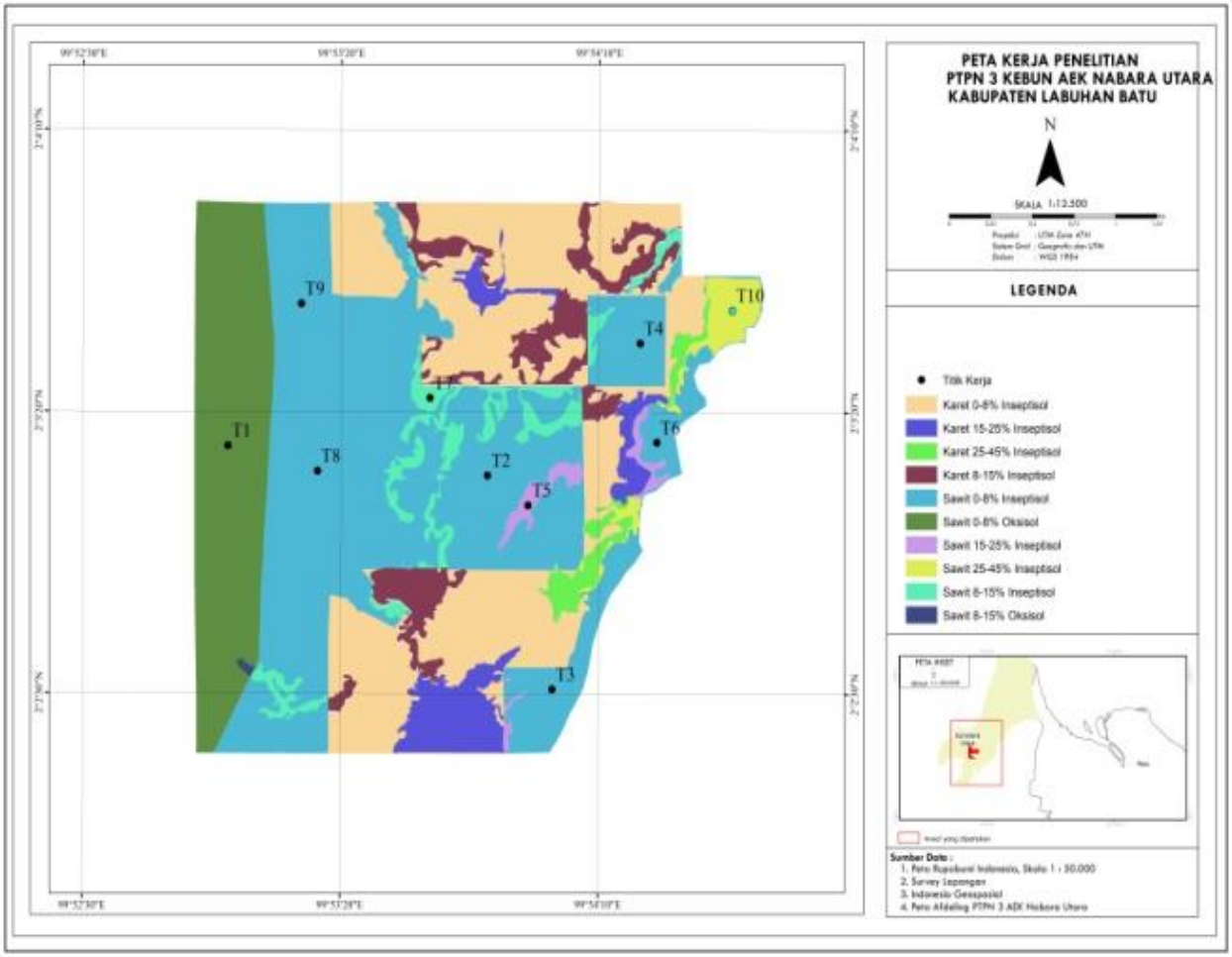

Figure 1. Map of taking soil sample points in the field

Tools and Materials

The materials used in this research were intact soil samples at depths of 0-30 and 30-60 cm and disturbed soil samples taken as a composite. The tools used are GPS (Global Position System), abney level, sample ring, mineral soil drill, field knife, hoe, cutter, plywood or board, plastic bags, rubber bands, labels, stationery, camera, office software, Arc software -GIS, Avenza MAP application, and Munsel Color Chart book.

Research Methods

The research was carried out using the methodsurvey with free grid measurements at semi-detailed survey level (observation frequency 1 sample per 500 meters). Carrying out soil sampling at up to 5 sampling points with a distance of 100 meters in the field using a random method, spread over a predetermined area based on the base map as shown in Figure 3 (Rauf and Harahahap, 2019). This research uses a direct survey method by selecting representative areas using the Purposive Random Sampling method in oil palm plantation areas. Observations were carried out by taking soil samples from 2 locations where sampling was carried out at a depth, namely from a depth of 0-30 cm, 5 samples each. at the same depth to examine the physical content of the soil. Soil samples were taken on the following land: T 1 = Slope Slope 0-8%, T 2 = Slope Slope 8-15%.

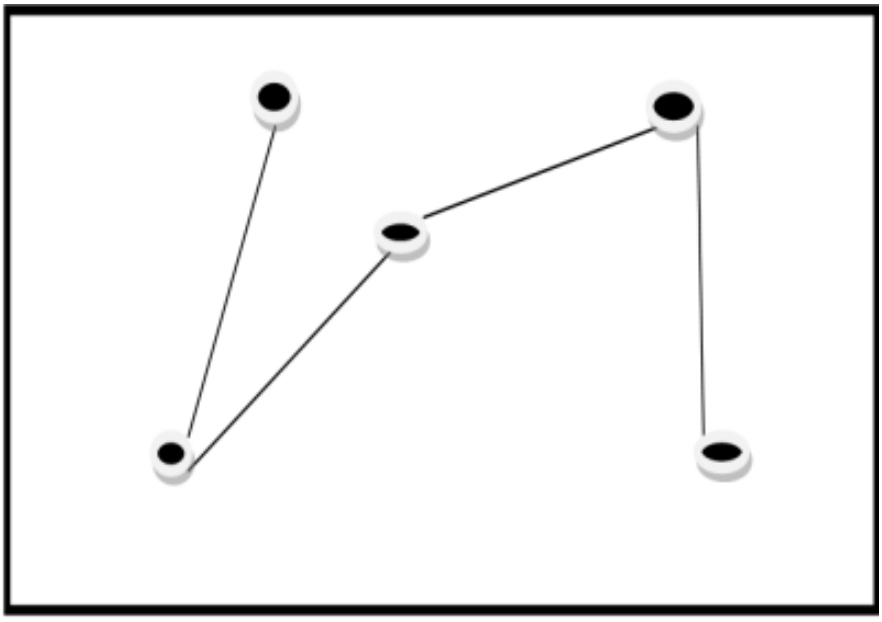

Figure 2. Taking soil sample points in the field

The parameters measured in this research are:Bulk Density (g/cm3) Sample Ring Method, Total Pore Space (%) Sample Ring Method and Water Content Measurement), Soil Structure Field Method, Soil Water Content (%) Gravimentry Method, Soil Texture (%) MethodHydrometerand USDA Triangle

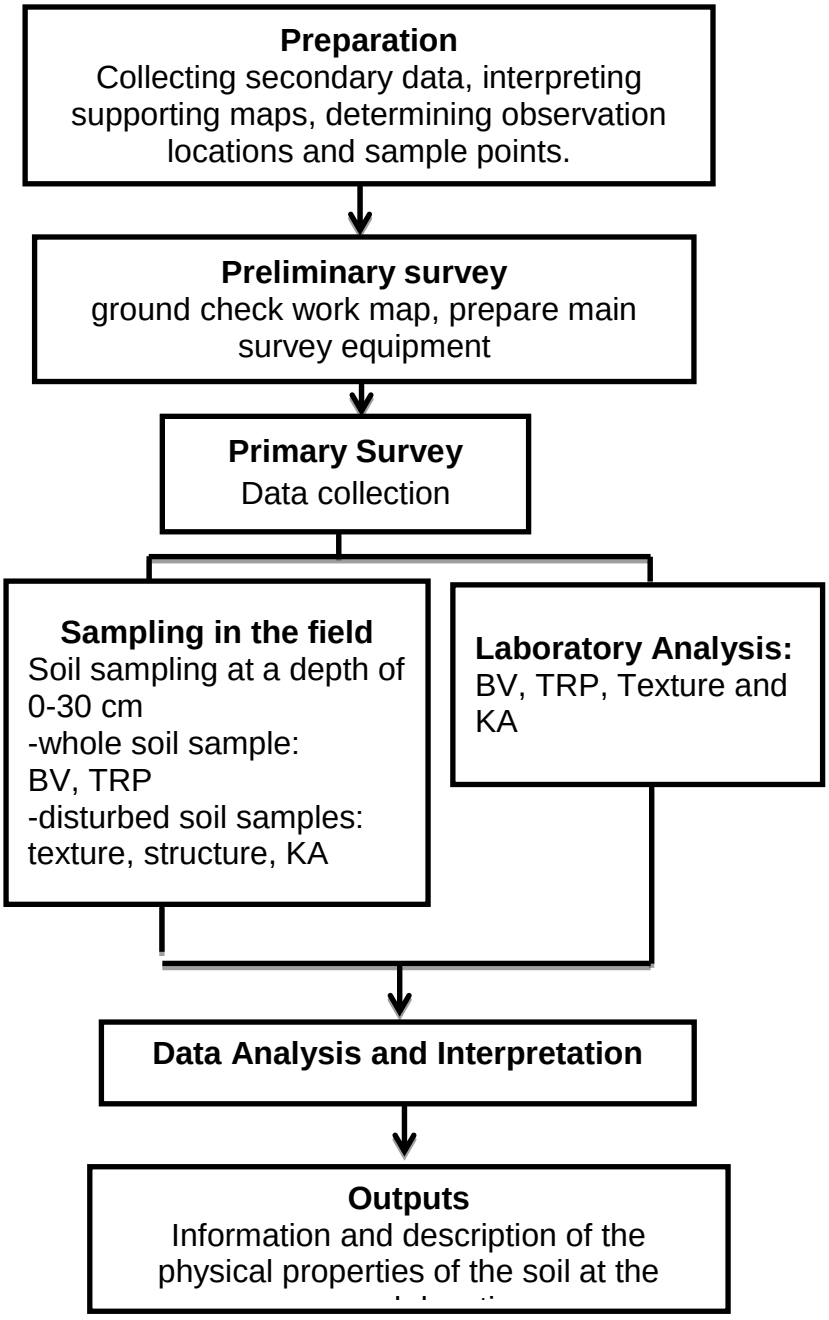

Figure 3. Research Flow Diagram

3. RESULTS AND DISCUSSION

3.1 Soil Bulk Density and Total Soil Pore Space

Bulk Density of soil or unit weight is the ratio between the weight of dry soil and the Bulk Density of soil. The denser the soil, the higher the Bulk Density value of the soil, making it more difficult for the soil

to be penetrated by water and plant roots (Hardjowigeno 2015). Soil bulk density is greatly influenced by the soil organic matter content, soil processing system and soil texture. The results of the analysis of soil Bulk Density and total soil pore space can be seen in Table 1.

Table 1. Results of soil Bulk Density analysis and total soil pore space

Sample	BD (g/cm3)	TRP (%)
T1	1.44	0.17
T2	1.41	0.38
T3	1.55	0.38
T4	1.55	0.17
T5	1.54	0.17
T6	1.30	0.58
T7	1.32	0.38
T8	1.53	0.17
T9	1.50	0.38
T10	1.55	0.17

Based on Table 1, it can be seen that the Bulk Density of the soil at each sample point is divided into two classes, namely medium class (T1, T2, T6, and T7) and high (T3, T4, T5, T8, T9, and T10). The Bulk Density of the soil is high because previously land was cleared using heavy equipment which resulted in the soil becoming denser due to the track of the heavy equipment wheels. This is caused by the influence of root development which will break up the soil so that the soil is less dense. In addition, the level of vegetation density is increasing so that it can protect the soil from rainwater impact.Several factors influence the level of BD in a soil, namely the organic matter content of the soil, soil texture, number of soil pores, and plant roots. High soil organic matter content can cause the soil BD value to decrease. Organic matter will increase the number of soil pores so that the density of the soil will decrease.

According to Islami and Utomo (1995) in Prasetyo et al (2014) that the volume weight value of soil is influenced by structure (in terms of pore space), soil texture (in terms of particle size and density) and organic matter content. According to (Baskoro and Tarigan 2007) soil with high levels of organic matter tends to have good and stable soil physical properties. One of the physical properties of stable soil is low soil BD because it has a larger total pore space.

The presence of land processing activities and low levels of canopy density will cause an increase in soil volume weight. Raindrops that fall will directly hit the ground so that the soil will become denser (Putri et al. 2017). A high level of canopy density can protect the soil surface from being destroyed due to the impact of rainwater, so that there is no blockage in the soil pores
(Sandrawati, Setiawan, and Kesumah 2016)

The total value of soil pore space in table 1 is included in the low class. The higher the age of the plant, the higher the organic matter content, the higher the organic matter content of a soil, the TRP of a soil will also increase. This is supported by the statement of (Yulipriyanto 2010) which states that the advantage of high levels of organic matter can reduce the

weight of soil volume. Low soil volume weight is related to increased soil porosity due to the presence of organic and inorganic fractions in the soil. According to (Kusuma and Yulfiah 2018) soil pores are related to soil texture, where pores are generally occupied by air for coarse pores, while small pores are occupied by water. The factors that influence the porosity value are the grain size and specific gravity of the soil. the amount of pore space will be influenced by the arrangement of the solid grains. The size of the pores in the soil grain structure will determine the number and nature of the pores. The results of this study show that the volume weight of soil is inversely proportional to TRP. The lower the weight value of a land, the more the TRP value of a land will increase. According to (Hardjowigeno 2015), soil that has a low volume weight has a high total pore space value, whereas soil that has a high volume weight has a low total pore space value.

3.2 Soil Water Content

Soil water content is expressed as a comparison value between the mass/weight of water in the soil sample before drying and the mass/weight of the sample after drying until the mass/weight remains at a temperature of 105°C (Kurnia et al. 2006). Soil water content in this study can be seen in Table 2

Table 2 Soil water content

Sample	Water content (%)
T1	0.20
T2	0.27
T3	0.25
T4	0.26
T5	0.27
T6	0.26
T7	0.30
T8	0.25
T9	0.26
T10	0.24

According to (Murniyanto 2007), the increase in water content is due to the physical binding of organic materials and an increase in the infiltration rate. However, as long as the organic material has not been completely decomposed, it does not always guarantee an increase in water stored in the soil. Apart from that, the amount of water stored in the soil is related to the volume weight of the soil, and the volume weight itself is influenced by organic matter.

The amount of available water that will be used by plants is influenced by the texture, structure, organic matter content and depth of the soil (Sinaga, Amelia, and Batubara 2020). High soil density conditions can affect soil porosity to low. Decreased soil porosity can reduce the soil's ability to store water (Hanafiah KA 2005).High soil porosity causes water to easily enter the soil, as a result the groundwater holding capacity also increases (Majid 2010).

3.3 Soil Structure

Soil structure is the bonding of primary grains into secondary grains or aggregates. The arrangement of primary grains in the aggregate determines the type of soil structure. Soil structure is an

important characteristic in determining the physical condition of the soil and the development of plant roots. Soil aeration, nutrient availability and soil microbial activity as well as the breakdown of soil organic matter (Utomo, 2016). The results of soil structure research in the field can be seen in Table 3. In general, the soil structure at the research location is angular lumps.

The results of soil structure analysis in the field can be seen in table 3.

Table 3. Results of soil structure analysis

Sample	Soil Structure
T1	Angular lump
T2	Angular lump
T3	Angular lump
T4	Angular lump
T5	Angular lump
T6	Angular lump
T7	Angular lump
T8	Angular lump
T9	Angular lump
T10	Angular lump

3.4 Soil Color

Color is an indication of several soil properties, because soil color is influenced by several factors in the soil. Soil color is determined using standard colors contained in the Munsell Soil Color Chart book, in this book colors are arranged by three variables, namely: hue, value and chroma.The results of soil color analysis in the field can be seen in table 4.

Table 4. Results of soil color analysis in the field

Sample	Color
T1	10 YR 5/6 (Yellowish Brown)
T2	10 YR 5/8 (Yellowish Brown)
T3	10 YR 4/4 (Brown)
T4	10 YR 3/4 (Drak Brown)
T5	10 YR 4/6 (Brown)
T6	10 YR 5/8 (Yellowish Brown)
T7	10 YR 4/6 (Brown)
T8	10 YR 5/6 (Yellowish Brown)
T9	10 YR 4/4 (Brown)
T10	10 YR 4/4 (Brown)

3.5 Soil Texture

Soil texture is the relative ratio between dust, sand and clay fractions. Soil texture influences the size and speed of water entering the soil, water storage in the soil, aeration and soil processing (Utomo, 2016). Based on the results of soil tests at the research location, it can be seen in Table 3 that in general the soil texture class at the research location is clay. According to Darmawijaya (1990), soil texture is the only physical characteristic of soil that is permanent and cannot be easily changed by human hands if it is not added from elsewhere.

Table 4. Soil Texture

Sample	Texture			Keterangan
	Sand(%)	Dust (%)	Clay(%)	
T1	21,57	21,97	56,46	Clay
T2	12,78	21,43	65,79	Clay
T3	14,61	23,66	61,73	Clay
T4	10,44	21,43	68,08	Clay
T5	8,67	25,67	65,67	Clay
T6	17,72	24,01	58,27	Clay
T7	10,76	25,68	63,56	Clay
T8	6,51	27,81	65,68	Clay
T9	8,28	30,07	61,65	Clay
T10	11,74	30,36	57,90	Clay

The ability to retain water and plant nutrients is high. The existing water is absorbed, making clay soil heavier, especially when dry, leaving less water for plants. Clay soil is soil that contains sand, silt and clay in such a way that its properties are between sandy soil and clay. so that the aeration is quite good, the storage capacity and supply of water to the plants is high. The composition of clay is better than clay because it is dominated by sand, so it has lots of macro pores (pores) which allows water and air to circulate more easily (drainage and aeration). This is supported by Setyowat's (2007) statement that the higher the proportion of sand in the soil, the more pore space there is between soil particles so that it can facilitate the movement of air and water.

4 CONCLUSION

The conclusions obtained in this research from the physical properties of the soil show a Bulk Density value of 1.30 – 1.51 g/cm^3, Total Pore Space 0.17-0.58%, water content 0.20-0.27%, while the texture is dominantly clayey, and the structure is dominantly angular blocky. The physical properties of soil require a long time to change, because the physical properties of soil are difficult to change.

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