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Identification of Available Nutrients NPK of Oil Palm Soil (*Elaeis guineensis* Jacq) in the Phase of Immature Plants

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ABSTRACT

Oil palms that experience nutrient deficiencies will affect their vegetative and generative growth and even cause plant death. This study aims to determine the chemical properties of soil in oil palm plantations at the plant phase before producing fruit. This study was conducted at an oil palm plantation owned by PTPN III Kebun Aek Nabara Utara, Labuhanbatu Regency, and analyzed at the Soil Laboratory of the Faculty of Agriculture, University of North Sumatra. The method used is the observation method, sampling in the field, and analysis in the laboratory to obtain quantitative data. Observation parameters include soil pH, C-organic, Total Nitrogen, Available P, Cation Exchange Capacity, and Base Saturation. The results of the study showed that the level of soil fertility at the research location was included in the low category. The main limiting factor that causes low soil fertility is the low organic matter content of the soil and to improve the soil fertility status at the research location so that the availability of nutrients for plants is more sufficient.

Keywords: *Chemical properties, Conversion, Oil palm plants, Nutrients, Quantitative data*

1. INTRODUCTION

Oil palm (*Elaeis guineensis* Jacq.) is the main plantation crop in Indonesia. Oil palm is an important commodity because it has the highest yield compared to other vegetable oils, which can produce 5.5-7.3 tons of CPO/ha/year (PPKS, 2013). On the other hand, exports of crude palm oil (CPO) and its derivative products in 2013 reached 20.5 million tons worth 15.8 billion US dollars (Directorate General of Plantations, 2014). Indonesia is currently the largest palm oil producer in the world followed by Malaysia and Thailand. In 2014, Riau Province with an area of 2.30 million ha was the province with the largest oil palm plantation in Indonesia, followed by North Sumatra Province with an area of 1.39 million ha, Central Kalimantan Province with an area of 1.16 million ha, and the remaining 6.10 million ha filled by other provinces in Indonesia.

Land conversion is generally used for plantation areas such as oil palm. The Ministry of Forestry has increasingly issued permits for the conversion of forest areas for plantations covering an area of 6.7 million ha until 1997. The conversion of forest functions for other uses has been proven to be a threat to the existence of forest areas. With the felling of trees, the moist soil conditions supported by a hotter microclimate will accelerate the decomposition process of the remaining plant remains (Pratiwi, 2002).

The decrease in the level of soil organic matter will worsen the physical and chemical properties of the soil (Barchia, 2009). The level of chemical fertility of the soil such as the content of the main nutrients (N, P, K), soil acidity (pH), cation exchange capacity (CEC), and organic matter content (C/N ratio) are important parameters to determine the decline in soil fertility due to land conversion. The amount of organic matter, soil type, and amount of clay minerals determine the cation exchange capacity in the absorption complex and will affect the movement of nutrients from the soil to the plant roots. The higher the cation exchange capacity, the higher the ability of the soil absorption complex to bind cations. The ability of a high cation exchange rate reflects the value of soil fertility (Jumin, 2002)

The age and type of vegetation can also affect soil properties and soil quality because different types and ages of vegetation have different abilities to protect the soil from erosion. This is due to differences in the area of plant canopy that covers the soil at various levels of plant age (Yasin, S. 1991).

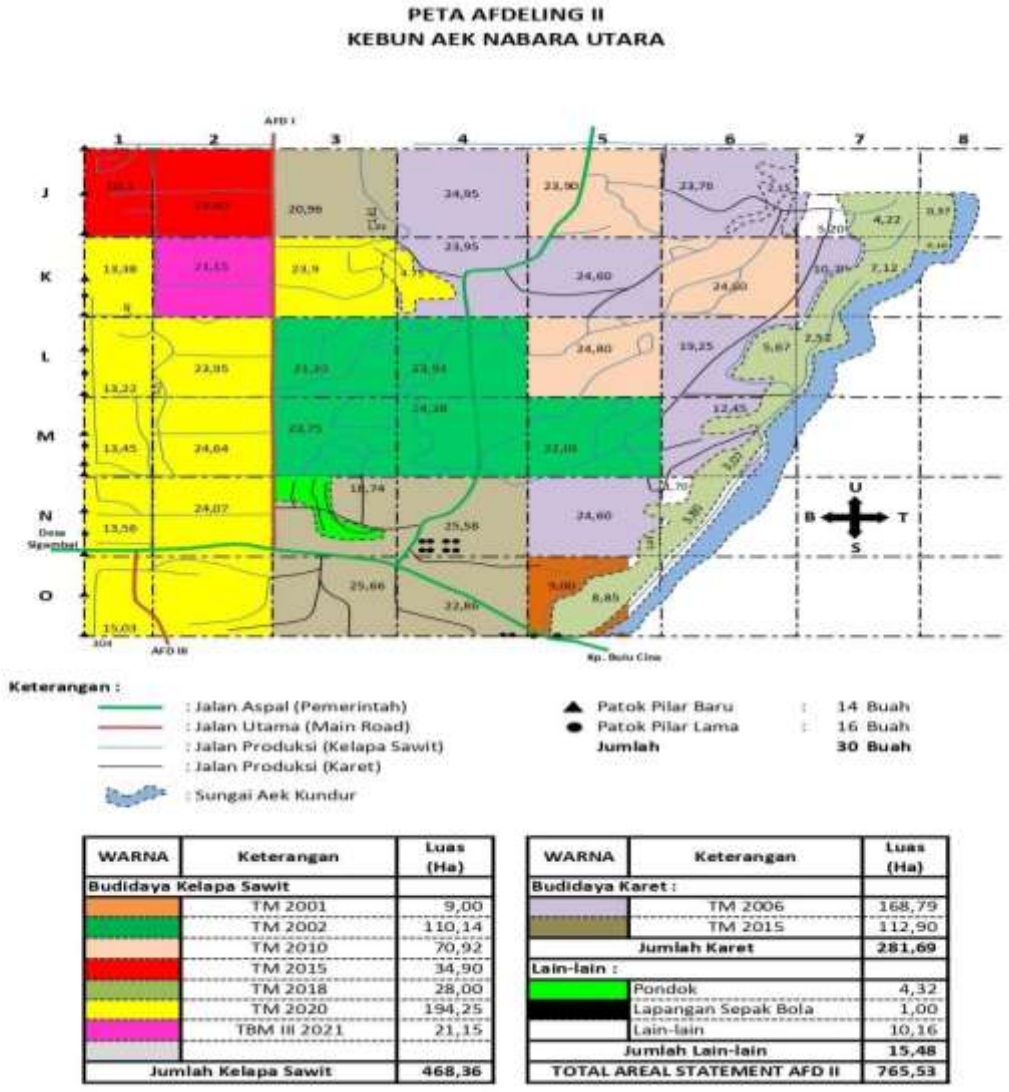
Oksana et al., (2012) said that the fertilization treatment given to oil palm plantations on the soil greatly affects the availability of total N content in the soil. The decrease in the total N value of the soil along with the increasing age of the plant is thought to be due to the degradation of organic matter and changes in soil pH which are not significant and are still classified as very acidic. Wigena, et al., 2009 said that the fertilization treatment given will help increase the cation exchange capacity. Meanwhile, the ongoing decomposition process produces humic compounds that can improve the CEC of the soil (Dairiah Nurida., 2011). According to Rusdiana and Lubis (2012), the high cation exchange capacity value is influenced by soil pH and the availability of organic matter. This degradation of organic matter and organic C is what causes the decrease in soil CEC.

Several considerations that have been mentioned above are very interesting to be studied further to find out how the characteristics of chemical properties of the soil under oil palm stands are both under stands that have been produced and stands that have not been produced after 4 planting cycles

2. MATERIAL AND METHODS

The research was conducted on immature oil palm plants owned by PTPN III Kebun Aek Nabara Utara, Labuhanbatu Regency with a height of 29

meters. This research was conducted from October 2023 to January 2024 on oil palm plantations and analyzed at the Soil Laboratory of the Faculty of Agriculture, University of North Sumatra.



WARNA	Keterangan	Luas (Ha)
Budidaya Kelapa Sawit		
	TM 2001	9,00
	TM 2002	110,14
	TM 2010	70,92
	TM 2015	34,90
	TM 2018	28,00
	TM 2020	194,25
	TBM III 2021	21,15
Jumlah Kelapa Sawit		468,36

WARNA	Keterangan	Luas (Ha)
Budidaya Karet :		
	TM 2006	168,79
	TM 2015	112,90
Jumlah Karet		281,69
Lain-lain :		
	Pondok	4,32
	Lapangan Sepak Bola	1,00
	Lain-lain	10,16
Jumlah Lain-lain		15,48
TOTAL AREAL STATEMENT AFD II		765,53

Figure 1. Map of soil sampling points in the field

The study began with soil sampling and the method used was the observation method, sampling in the field and analyzed in the laboratory to obtain quantitative data. The method used in this study is the free grid measurement method at the semi-detail survey level.

Sampling was carried out using the random sampling method at predetermined points in each block, sampling was carried out from two depths, namely from each of the 2 samples at the same two depths for chemical content examination. exploring soil properties with certain criteria that have been determined.

To determine the chemical properties of the soil with certain criteria that have been determined based on the Technical Instructions for Soil Fertility Evaluation (PPT, 1995) presented in Table 1.

The soil samples were analyzed to determine the nutrient content, namely soil pH, Nitrogen (N) Kjeldah method in % units, Phosphorus (P) HCL 25% method in mg/100 units, C-Organic Walkey and Black method in % units, Cation exchange capacity and Base Saturation.

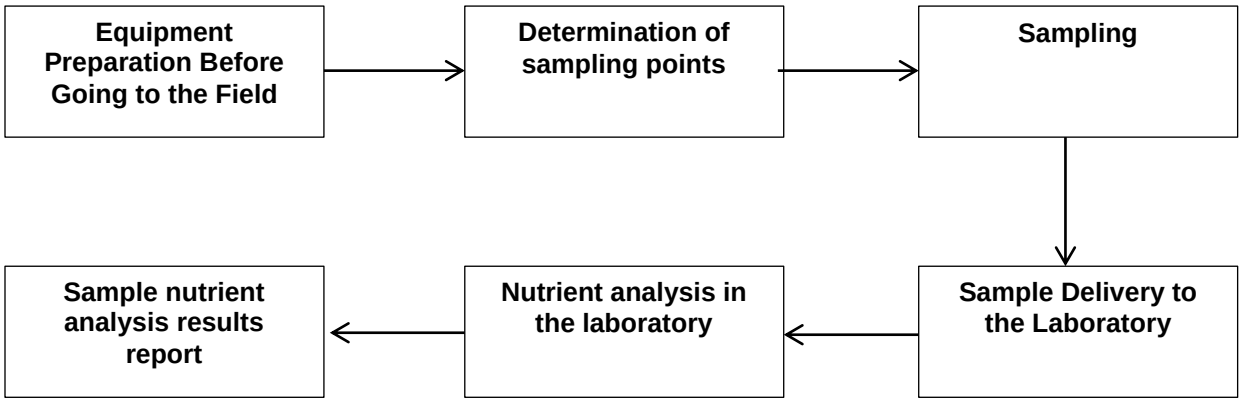


Figure 2. Research flow diagram

3. RESULT AND DISCUSSION

Primary data (analytical data) obtained from the results of soil analysis in the laboratory are graded according to the PPT Bogor soil fertility grading (1995). So it is known that the grade of the chemical fertility parameters of the soil is included in the low, medium, and high status as seen in Table 1. The results of measuring soil fertility parameters and the status of plant nutrients that have not produced oil palm are presented in Table 2.

Table 1. Results of nutrient analysis on each sample

Parameter	Unit	Samples			
		I	II	III	IV
Soil pH		4.91	5.67	5.65	5.27
N-Total	%	0.13	0.19	0.12	0.18
P2O5	ppm	46.50	32.86	42.88	26.33
C-Organic	%	1.72	1.15	1.34	1.62
CEC	me/100 gr	10.72	9.85	9.48	10.28
KB	%	17.91	10.80	7.54	20.12

Table 1 Results Show that the soil pH at the research location is included in the slightly acidic category, which ranges from 4.91-5.67. Soil pH is a soil reaction that indicates the acidity or alkalinity of the soil. Soil pH plays an important role in determining how easily nutrients are absorbed by plants. Nutrients can generally be absorbed well by plants at neutral pH. Soil microorganisms and fungi can grow well at a pH above 5.5 if less then their activity will be inhibited. Low soil pH will cause plants to be unable to utilize N, P, K, and other nutrients needed. Low pH also causes the availability of toxic elements such as aluminum which always poisons plants and also binds phosphorus so that it cannot be absorbed by plants (Hardjowigeno 2007). Soil

Base Saturation (KB) Base saturation is the ratio between the amount of exchanged base cations and the soil CEC expressed in percent. The soil at the research location has a low base saturation value with a value of 7.54 to 20.12%. According to Bohn et al. (2009), the CEC value of soil is usually directly proportional to the soil KB, because base saturation is a reflection of the high number of cations in the soil colloid complex. The addition of fertilizer during planting is one of the reasons for the increase in CEC at the research location. In addition to CEC, base saturation also determines soil fertility. Base saturation is the ratio between the number of base cations exchanged and the cation exchange capacity (CEC) of the soil expressed in percent. Base

saturation at the research location is included in the moderate and very high categories. The CEC value of soil is usually directly proportional to the base saturation (CEC) of the soil because base saturation is a reflection of the high number of cations in the soil colloid complex (Bohnet 2009).

Table 2. The results of measuring soil fertility parameters and the status of plant nutrients

Soil Parameter	Very Low	Low	Moderate	High	Very High
C-organic (%)	< 1.00	1.00-2.00	2.01-3.00	3.01-5.00	> 5.00
Base Saturation (%)	< 20	20-35	36-50	51-70	> 70
P2O5 HCl 25%	< 10	10-20	21-40	41-60	> 60
K2O HCL 25%	< 10	10-20	21-40	41-60	> 60
CEC (me/100 g)	< 5	5-15	17-24	25-40	> 40

Soil C-organic content The results of determining the C-organic content at the research location with low criteria are between 1.34-1.72%. This is thought to be because in oil palm cultivation at the research location, organic fertilizers are rarely added, only inorganic fertilizers are given. Low organic C content indirectly results in low oil palm production, because soil organic matter is one of the parameters that determine soil and plant productivity (Susila, 2013). The results of measuring the total phosphorus content of the soil from each planting year's land were very moderate with a value of 23.43 - 46.50 ppm. This is also in line with the low organic matter content at the research location. The P elements in the soil come from organic matter (manure and plant residues) in addition to phosphate minerals in the soil (apatite) (Sukisno et al., 2011). The research location's land is rarely added with organic matter which ultimately impoverishes soil fertility. Phosphorus is the second essential macro element after nitrogen which is very much needed by plants and functions in cell division, albumin formation, flower, fruit, and seed formation, accelerating ripening and strengthening stems so that they do not fall easily. Phosphorus elements in the soil come from organic matter, soil minerals and artificial fertilizers (Herawati 2015).

Cation exchange capacity (CEC) is an indicator of soil fertility. The soil at the research location has a CEC value between 9.48-10.72me/100 with low status. Based on this fact, Sufardi, et al. (2017) stated that one of the things that affects the CEC value of the soil is the soil humus content and the type of clay minerals. Soil dominated by Al and Fe oxide-hydrate fractions usually has a low negative charge on the colloid surface (Sposito, 2010), so the CEC value of the soil is usually low. This is in line with the generally low organic matter content at the research location. Naturally, the organic matter content of the soil in tropical areas decreases rapidly and the decrease reaches 30-60% within 10 years (Sufardi et al., 2017).

Evaluation of Soil Fertility Status According to Poerwowidodo, (1992) in Husni (2016) Soil fertility is the ability of soil to provide nutrients, at certain doses and balances to support the growth of a type of plant in an environment with other growth factors in favorable conditions. Sutedjo (2002) added that fertile soil has sufficient availability of nutrients available to plants and there are no limiting factors in the soil for plant growth. Soil fertility status is the condition of soil fertility in a certain place and time which is assessed based on standard criteria for soil fertility parameters according to technical instructions for soil fertility evaluation. Soil Research Center, PPT Bogor 1995 (Susila, 2013). Based on the

determination of soil fertility status based on technical instructions for soil fertility evaluation of the Soil Research Center, Bogor (PPT, 1995) shows that the assessment of the overall fertility status of oil palm plantation land is low fertility status. The low fertility status at the research location was caused by limiting factors, namely the low content of soil organic C and soil base saturation. The content of C-organic (organic matter) in the soil greatly influences the ability of the soil to maintain soil fertility and productivity through the activity of soil organisms, many soil properties, both physical, chemical, and biological, are directly and indirectly influenced by organic matter.

Organic matter also plays a role in the formation of soil aggregates. The addition of organic matter must be given because soil organic matter plays a very important role in creating soil fertility. Furthermore, soil base saturation is always associated as an indication of the fertility of soil. The ease of releasing ions that are absorbed by plants depends on the degree of base saturation. The soil is very fertile if the base saturation is > 80%, if the base saturation is between 50-80% the soil fertility is moderate and the soil is not fertile if the base saturation is < 50%.

4. CONCLUSION

The soil nutrient levels at the research location are included in the low category. The main limiting factor that causes low soil nutrient levels is the low organic matter content of the soil. To improve the soil nutrient status at the research location, efforts are needed in the form of fertilization and the addition of organic matter so that the availability of nutrients for plants is sufficient.

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