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Some chemical properties of mineral soil under peat layer at Sriwijaya Botanical Garden

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ABSTRACT

Natural peat forms from partially decomposed plant remains, at least 50 cm thick, accumulating in swamps over alluvial subsoil. The research aimed to identify peat maturity, peat depth and color of mineral soil. Additionally, to identify some soil chemical properties such as soil pH, N-total, C-organic and P-available under the peat layer in Siwijaya Botanical Garden. This study used a detailed survey method at a scale of 1:8,000 on peatland areas in Sriwijaya Botanical Garden covering 77 ha. Sampling was conducted using the systematic sampling method. The analysis of soil chemical properties was conducted in the laboratory. The study results showed that the thickness of the peat at the study location was dominantly very deep with a peat depth of >300 cm, the color of the mineral soil in the peat layer was predominantly gray and very dark gray, the pH value of the soil was very acidic with a value of <4.5, the C-Organic value was categorized as average to very high, the N-Total value was categorized as very low to average and the P-Available value was categorized as very low to low. Peat depths of more than 300 cm should be planted with conservation crops and further research needs to be done on the relationship between the chemical properties of the mineral soil under peat layers and the chemical properties of the peat soil.

Keywords: mineral soil, peat, peat dept, soil chemical, soil fertility

INTRODUCTION

Peat soil was composed of accumulated plant material, both decomposed and undecomposed (Gunanta, 2014). Beneath this layer lies a substratum of alluvial soil (Soewandita, 2018). Alluvial soil was categorized as mineral soil, formed through the physical and chemical weathering of parent rock, followed by sedimentary deposition processes (Wasis et al., 2019). The Sriwijaya Botanical Garden, situated in Bakung Village, North Indralaya District, Ogan Ilir Regency, was predominantly characterized by peat soils (Komalasari et al., 2019). The site has a soil pH of 5.5, a peat layer measuring 400–475 cm in thickness, an elevation of 20–22 m above sea level, and a groundwater table at a depth of 15–20 cm. The landscape begins with mineral soils dominated by fibric maturity; however, the chemical properties of these mineral soils remain unstudied (Herawati & Maryani, 2018).

The chemical analysis of peat soil was generally carried out on the top layer (Virmanto et al., 2022). The peat soil in Sriwijaya Botanical Garden was classified as topogen peat. Topogen peat was formed in an environment influenced by tidal or river water, located directly above the mineral soil (substratum) at the bottom of a basin or lake (Pribadi et al., 2016). (Nopsagiarti et al., 2020) said that soil acidity was caused by a variety of processes, including the original soil composition, organic matter, aluminum hydrolysis, mineral oxidation processes and alkaline leaching. Soil pH analysis could be conducted in the field with litmus paper (Kambuaya et al., 2019). Even though it was faster to do the analyses in the field, the soil pH value accuracy was more accurate in laboratory analysis (Apriyanti et al., 2018).

Soil pH analysis in the laboratory used a pH meter because soil pH analysis in the laboratory was more accurate as it was done with more advanced equipment and more careful methods (Sari et al., 2021). The determination of peat maturity using the squeezing test was based on the results observed in the field (Muslikah & Yuliana, 2021) and the thickness of the peat layer was measured using a peat drill, which was pushed into the ground until it reaches the mineral soil layer.

The sampling depth was recorded, and soil samples were collected using the wing of a peat drill (Khalil et al., 2023). Soil color was determined by comparison with the Munsell Soil Color Chart and described in terms of hue, value, and chroma (Fitriani et al., 2022). Organic carbon was quantified using the Walkley and Black method (Kusuma & Yanti, 2022), while total nitrogen was determined by the Kjeldahl method (Winingsih et al., 2019). Available phosphorus was assessed using the Bray method for soils with pH $\leq$ 5.5 and the Olsen method for soils with pH > 5.5 (Umaternate et al., 2014). The objectives of this study was to characterize peat maturity, peat thickness, and mineral soil color, as well as to evaluate selected soil chemical properties, including pH, total nitrogen, organic carbon, and available phosphorus beneath the peat layer in the Siwijaya Botanical Garden.

MATERIALS AND METHODS

Study Area

This research was carried out at Sriwijaya Botanical Garden, Bakung Village, North Indralaya District, Ogan Ilir Regency. Analysis of soil chemical properties was carried out at the Soil Chemistry and Fertility Laboratory, Faculty of Agriculture, Sriwijaya University. This research was conducted in October 2022.

Equipment and Materials

The materials that have been used were soil samplings, distilled water, buffer solution, KCl 1 N, selen mixture, boric acid 4%, sulfuric acid 0.1 N, sodium hydroxide 40%, Conway's instructions, potassium dichromate 1 N, ferrous ammonium sulfate 1 N, concentrated sulfuric acid pa, Concentrated phosphoric acid pa, Sodium fluoride 4%, Indicator diphenlamine, Indicator ammonium flouride (NH_4F) 1 N, Hydrochloric acid 0.5 N 0.4 ml HCL, Extract solution (PA) 30 ml ammonium flouride added 50 ml HCL 0.5 N, Ammonium molybdat solution (PB).

The equipment that has been used were Stationery, Peat drill (Eijkelkamp), Global Positioning System (GPS), Wrench, Plastic bag, Mat, Meter, Field knife, Analytical balance, 2 decimal, pH meter, Film tube, 25 ml measuring cup, Stirring cup, Sprayer, 250 ml Erlenmeyer, 50 ml Burette, Measuring cup 10 ml, Measuring cup 100 ml, Measuring pipette 10 ml, Drip pipette, Kjeldahl flask 50 ml, Kjeldahl flask 500 ml, Deconstruction apparatus, Distiller, Micro burette, Erlenmeyer 50 ml, Rubber Suction, Test tube, Filter paper W42, Shaking machine, Spectrophotometer, Munsell Soil Color Chart.

Research Methods

This study used a detailed survey method (Rachmadiyanto et al., 2020) 1:8,000 scale on peatland area in Sriwijaya Botanical Garden with the study area of 77 ha (Figure 1). A detailed soil survey was carried out to get a lot of sample points in the field (Ginting et al., 2015). Sampling determination using the systematic sampling method, 11 samples were taken, one sample representing of 7 ha of mineral soil under the peat layer. The benefits of the systematic sampling method were its increased data representation and ease of implementation (Firmansyah & Dede, 2022).

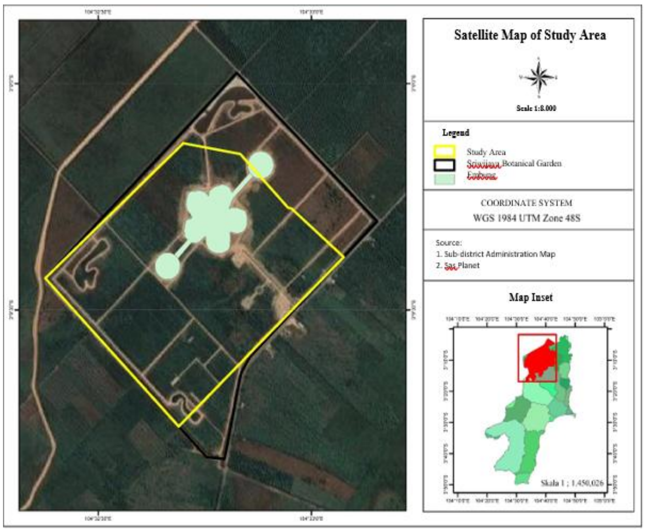

Figure 1. Satellite map of study area

Preparation

Preparation began by consultations, carrying out literature study activities relevant to the study topic, continued with field observations that involved reviewing the study area to get an overview of field conditions. In addition, permission for the research site was obtained, and preparation of the tools and materials required to carry out the activities was carried out.

Field Activities

Conducted a pre-survey, A pre-survey was the first step towards organizing the main survey. This step involves looking for more detailed information on all aspects related to the administration of the data (Tarigan et al., 2015). Then the main survey was carried out by visiting the research location to determine the GPS coordinates that would be used as a reference in making the observation map and determining the location of the sample points. Next, drilling was carried out using a peat drill at each sample point until the substratum was found, in order to measure the depth and check the maturity level of the peat and the color of the mineral soil. After identifying the mineral soil layer below the peat layer, soil samples were taken for laboratory analysis.

Laboratory Analysis

The analyzes were carried out at the Chemistry, Biology and Soil Fertility Laboratory of the Department of Soil, Faculty of Agriculture, Sriwijaya University, with the analysis of soil chemical properties including soil pH analysis (pH meter), Nitrogen (Kjedhal Method), Phosphorus (Bray Method) and C-organic (Walkley and Black Method) (Tewu et al., 2016).

Data Analysis

Data from the field activities and laboratory analysis were then categorized and presented in a descriptive table to ease the discussion

RESULTS

General Site Condition Observations

The study area was a designated conservation zone comprising three reservoirs, sluice gates, lakes, and a network of primary and secondary waterways within each tertiary channel block. At the time of sampling, the site exhibited minimal inundation. The vegetation was dominated by species characteristic of wetland and flood-prone environments, including Melaleuca cajuputi (gelam), Lepironia articulata (purun), and swamp jelutong, with Melastoma malabathricum (seduduk) observed on previously burned sites. Peat coring conducted during sampling indicated peat depths exceeding 500 cm.

Physical Properties of Soil

Thickness of Peat

The thickness of the peat in the study area was on average very deep because the thickness of the peat was >300 cm and it was a conservation area. The first measurement conducted by the Sriwijaya Botanical Garden Master Plan Review Team (2012) showed that the depth of peat in the Sriwijaya Botanical Garden ranged from 315-679 cm. However, when compared to the data obtained from field activities, which ranged from 116-535 cm, it could be said that subsidence has occurred (Table 1).

Table 1. Peat thickness at the study area

Criteria	Thickness (cm)	Sample Point	Area
Medium	116	T_1	14 ha
	137	T_5	
Deep	216	T_2	14 ha
	252	T_4	
Very Deep	364	T_3	35 ha
	431	T_6	
	414	T_7	
	535	T_8	
	354	T_9	
	448	T_{10}	
	326	T_{11}	

Maturity of peat

The maturity rate at the study area was dominantly fibric (raw) based on the analysis in the area (Table 2). The peat environment which tends to be humid and waterlogged makes the decomposition process of plants be slower.

Table 2. Peat maturity at the study area

Maturity	Study Area Point	Area
Sapric	T1,T5	14 ha
Hemic	T3, T6, T9, T11	28 ha
Fibric	T2,T4,T7,T8,T10	35 ha

Color of mineral soil

The color of the mineral soil at the study area showed that the dominant soil color was Very dark gray and gray (Table 3), checking the soil color using the Munsell Soil Color Chart book.

Table 3. Color of mineral soil under peat layer of Sriwijaya Botanical Garden

Sampling Point	Soil Color	Description	Area
T1	5Y3/1	Very Dark Gray	28 ha
T5	5Y3/1	Very Dark Gray	
T6	5Y3/1	Very Dark Gray	
T10	5Y3/1	Very Dark Gray	
T4	5Y3/2	Dark Olive Gray	7 ha
T8	5Y4/1	Dark Gray	7 ha
T2	5Y5/1	Gray	28 ha
T3	5Y5/1	Gray	
T7	5Y5/1	Gray	
T11	5Y5/1	Gray	
T9	5Y7/1	Light Gray	77ha

Soil Chemical Properties

Analysis of soil samples in the laboratory yielded information on the values and categories of some soil chemical properties. The pH value of the mineral soil under the peat layer ranged from 3.01 to 4.26, which was classified as very acidic because it was <4.5. The C-organic content ranged from 2.25% to 16.61% and was categorized as medium to very high. The N-total content of the soil ranged from 0-02% to 0.37% with the variation of values classified as very low to medium. The variation of P-available value in the soil was 0.64 mg/kg 13.14 mg/kg where this value was classified as very low to low (Table 4).

Table 4. Laboratory analysis result of pH, C-organic, N-total and P-available

Sample	The Observed Variable				
	Maturity of peat	pH H_2O	C-Organic (%)	N-Total (%)	P-Available (mg/kg)
T1	Sapric	3.21^{SM}	16.61^{ST}	0.26^{S}	1.05^{SR}
T2	Fibric	3.73^{SM}	6.78^{ST}	0.07^{SR}	1.08^{SR}
T3	Hemic	3.78^{SM}	2.25^{S}	0.03^{SR}	1.82^{SR}
T4	Fibric	3.01^{SM}	12.32^{ST}	0.37^{S}	1.05^{SR}
T5	Sapric	3.07^{SM}	16.13^{ST}	0.27^{S}	0.97^{SR}
T6	Hemic	4.13^{SM}	2.89^{S}	0.06^{SR}	0.84^{SR}
T7	Fibric	4.26^{SM}	2.47^{S}	0.07^{SR}	3.78^{SR}
T8	Fibric	4.08^{SM}	3.71^{T}	0.11^{R}	13.14^{R}
T9	Hemic	4.23^{SM}	4.07^{T}	0.02^{SR}	0.64^{SR}
T10	Fibric	3.97^{SM}	3.31^{T}	0.06^{SR}	0.98^{SR}
T11	Hemic	3.98^{SM}	5.98^{ST}	0.02^{SR}	1.81^{SR}

Note: SM (Very Acid); ST (Very High); S (Medium); T (High); SR (Very Low); R (Low).

Data analyzed at the Chemistry, Biology and Soil Fertility Laboratory, Department of Soils, Faculty of Agriculture, Sriwijaya University. Soil Chemical Properties Assessment Criteria (SRC, 1983).

DISCUSSION

Field measurements indicated that peat thickness in the study area ranged from 116 to 535 cm. In contrast, the Sriwijaya Botanical Garden Master Plan Review Team (2012) recorded peat thicknesses of 315 to 679 cm, suggesting substantial subsidence. Subsidence is defined as the lowering of peat surfaces following reclamation or drainage, primarily due to the transition from anaerobic to aerobic conditions (Lisnawati et al., 2015). Additional contributing processes include compaction, decomposition, and surface erosion, which accelerate drying of the peat profile, particularly within the first two years after land clearing and drainage, when subsidence rates are highest. In subsequent years, subsidence typically stabilizes at 2–6 cm annually, depending on peat maturity and drainage depth, until approaching a quasi-equilibrium stage (Edi et al., 2017).

The maturity of the peat in the study area, based on field analysis, is dominantly raw (fibric) compared to hemic and sapric. Fibric peat refers to peatlands that were still in a raw condition, with a high content of plant tissue or plant remains that could still be seen in their original state. This type of peat is very slow to break down by microorganisms, so it is less fertile. Hemic peat is a type of peatland that has undergone decomposition and is half mature because of the decomposition of plant remains by microorganisms. Therefore, this type falls into the medium fertility category. Sapric peat is a category of peatland that has undergone advanced decomposition and reached a very mature level. The decomposition process carried out by microorganisms in this type is almost perfect to perfect, so this land is categorized as fertile with a high nutrient content (Irma et al., 2018). At fibric maturity (very raw peat), peat has a high porosity, so the spaces between peat masses were filled with water. However, because most of the water is in macro pores, when the peat is drained, water is quickly lost from these pores (Ayushinta et al., 2021). Generally, the fibric maturity level is likely to have low stability, and the raw weathering level indicates that the section remains saturated throughout the year based on the study (Lisnawati et al., 2015).

The color of the soil that has been observed using the Munsell Soil Color Chart book at the study area, the dominating colors were Very dark gray and gray. Soil color gives an indication of some soil characteristics, because the color is influenced by factors in soil composition (Handayani & Karnilawati, 2018). Soil color is influenced by a variety of factors, including the organic matter that could make it dark or black, the content of primary minerals such as quartz and plagioclase that give it a grayish-white color, and iron oxides such as goethite and hematite that give it a brown to red color. Soil color is a clue to some soil properties because it is influenced by these factors. Differences in soil surface color were generally caused by variations in organic matter content. When organic matter content is higher, soil color tends to be darker. Organic matter may give the soil a gray, taupe, or brown color, unless certain basic materials such as iron oxides or salt deposition modify the color (Holilullah et al., 2015).

Laboratory analysis revealed that the pH of mineral soil beneath the peat layer ranged from 3.01 to 4.26, classifying it as very acidic (<4.5). The lowest pH was recorded in sample T4 (3.01), whereas the highest was observed in sample T7 (4.26). Soil acidity is primarily governed by the concentration of H^+ and Al^{3+} ions in the soil solution, in addition to factors such as soil mineral composition, parent material, rainfall, and the balance between H^+ and $OH^−$ ions. Variations in parent material pH reflect differences in constituent minerals, while nitric acid, a natural component of rainfall, further contributes to soil acidification. Organic matter and soil texture are also critical determinants: organic matter enhances water retention, thereby increasing the likelihood of H^+ release, whereas clay-rich soils with high cation exchange capacity promote acidic reactions (Prabowo & Renan, 2017). Soil pH exerts a strong influence on phosphorus (P) availability. Under acidic conditions, P availability is markedly reduced (Table 4). Increased acidity enhances the adsorption of P by Fe and Al oxides, thereby decreasing its availability in the soil solution. Although phosphate fixation occurs under both acidic and alkaline conditions, the extent of fixation intensifies with greater interactions between P and soil constituents. Over time, Al may be substituted by Fe, resulting in the formation of Fe–P compounds, which are less soluble than Al–P complexes (Firnia, 2018).

In the mineral soil analyzed at the laboratory, the C-organic value was 2.25% to 16.61% with medium-very high criteria. The high soil organic carbon is due to the weathering of litter. Soil C-organic occurs through a series of organic matter decomposition processes. The soil C-organic state is influenced by external factors such as soil type, rainfall, temperature, organic matter input from surface biomass, the impact of human activities, soil management practices, and atmospheric CO_2 levels (Farrasati et al., 2019). The N-total value of soil analyzed in the laboratory was found to be 0.02%–0.37% with very low to moderate criteria. This is due to the lack of vegetation contribution to organic matter in the soil, the low content of nitrogen elements, and the limited supply of organic matter from vegetation on the soil surface, and has not fully undergone the decomposition process. Nitrogen content in soil is also greatly influenced by environmental factors such as climate and vegetation type. Growth of above-ground vegetation and the rate at which it decomposes were the main factors influencing changes in soil nitrogen content (Rahmi & Biantary, 2014). At greater soil depths, there is a tendency for nitrogen content to decrease due to losses caused by leaching. Nitrogen is a nutrient that has high mobility in the soil, so it is likely to experience losses due to the leaching process (Sipahutar et al., 2014).

CONCLUSSION

In the study area, peat deposits are classified as very deep (>300 cm) and are predominantly characterized by raw (fibric) maturity. Chemical analysis of the associated mineral soils indicated that at the sapric maturity level, C-organic content was very high, while total nitrogen was moderate and phosphorus availability was very low. At the hemic level, C-organic content was generally moderate, accompanied by very low concentrations of total nitrogen and available phosphorus. In contrast, fibric peat exhibited very high C-organic content, whereas both total nitrogen and phosphorus availability remained consistently very low.

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REFERENCES

Apriyanti, H., Candra, I. N., Elvinawati, E. (2018). Characterization of the adsorption from iron metal ions isotherm on the soil in Bengkulu City. *Alotrop*, *2* (1), 14–19. https://doi.org/10.33369/atp.v2i1.4588

Ayushinta, R. D., Herlambang, S., Arbiwati, D., Maswar. (2021). Relationship of peat maturity with moisture content to carbondioxide (CO_2) emmision in Peat Soil Central Kalimantan. *Soil and Water Journal*, *18* (1), 11–20.

Edi, H., Barus, B., Baskoro, D. P. T. (2017). Mapping of peatland subsidence in peat hydrology Unit Jangkang River – Liong River in Bengkalis Island. *Journal of Soil Environment*, *19* (1), 13–18.

Farrasati, R., Pradiko, I., Rahutomo, S., Sutarta, E. S., Santoso, H., Hidayat, F. (2019). Soil organic carbon in North Sumatra oil palm plantation: status and relation to some soil chemical properties. *Journal of Soil and Climate*, *43*(2), 157–165. https://doi.org/10.21082/jti.v43n2.2019.157-165

Firmansyah, D., Dede. (2022). General sampling techniques in research methodology: literature review. *Scientific Journal of Holistic Education*, *1*(2), 85–114. https://doi.org/10.55927/jiph.v1i2.937

Firnia, D. (2018). Dynamics of phosphorus elements on each horison profile of acid soil. *Journal of Agroecotech*, *10*(1), 45–52. https://doi.org/10.30645/j-sakti.v1i2.46

Fitriani, D. A., Mahrup, M., Yasin, I., Bakti, L. A. A. (2022). Soil color trends and organic matter status in farmlands experiencing low cloud cover based on terra modis map in Lombok Island. *Journal of Soil Quality and Management*, *1*(1),1–6. https://doi.org/10.29303/jsqm.v1i1.3

Ginting, R. S., Mukhlis, Sitanggang, G. (2015). Survey and mapping nutriens status of P at sub-district of Kabanjahe Regensi of Karo. *Agroecotechnology Online Journal*, *3*(3), 1226–1232.

Gunanta, R. (2014). Model test of retaining wall with peat backfill using flexible polypropilene reinforcement. *Journal of Civil Engineering and Environment*, *2*(3), 373–382.

Handayani, S., & Karnilawati, K. (2018). Characterization and classification of ultisol soils in Indrajaya District, Pidie Regency. *Journal of Agricultural Science*, *14*(2), 52–59. https://doi.org/10.31849/jip.v14i2.437

Herawati, M., Maryani, S. (2018). The thematic concept analysis of parks in sriwijaya botanical garden in supporting peatland conservation of South Sumatera. *Applied Research and Policy Publications, 1*(2), 49–55.

Holilullah, H., Afandi, A., Novpriansyah, H. (2015). Characteristics of soil physical properties in low and high production fields at PT. Great Giant Pineapple. *Journal of Tropical Agrotech*, *3*(2), 278–282. https://doi.org/10.23960/jat.v3i2.2014

Irma, W., Gunawan, T., Suratman, S. (2018). Effect of peatland conversion on environmental resilience in Kampar Watershed, Riau Province, Sumatera. *National Resilience Journal, 24*(2), 170–191. https://doi.org/10.22146/jkn.36679

Kambuaya, F., Beljai, M., Wanggai, C. B. (2019). The use of forest soil that intended for alternative medicine among local inhabitants of Mapura Village, District of Maybrat . *Papuasia Forestry Journal*, *5*(2), 142–152. https://doi.org/10.46703/jurnalpapuasia.vol5.iss2.147

Khalil, M., Syakur, S., Basri, H. (2023). Study of the morphology and physical properties of peat soil not planted and planted with oil palm in Aceh Jaya District. *Journal of Agriculture Student Science*, *8*(4), 758–769.

Komalasari, O., Maryani, S., Juairiyah, O., Susanto, T. (2019). Identification of medicinal plants in sriwijaya botanical garden and residency of Bakung Village, Ogan Ilir District. *Applied Research and Policy Publications*, *2*(1), 102–107.

Kusuma, Y. R., Yanti, I. (2022). Effect of water content in soil on c-organic levels and soil acidity (pH). *Indonesian Journal of Chemical Research*, *6*(2), 92–97. https://doi.org/10.20885/ijcr.vol6.iss2.art5

Lisnawati, Y., Suprijo, H., Poedjirahajoe, E., Musyafa, M. (2015). The impact of development of industrial plantation forest acacia crassicarpa in peatland towards the maturity level and subsidence rate. *J Journal of Human and Environment*, *22*(2), 179–186. https://doi.org/10.22146/jml.18740

Muslikah, S., Yuliana, I. (2021). The physical characteristics of Ogan Komering Ilir Peat Soil. *Research and Review Journal of Civil Engineering*, *10*(2), 79–84. https://doi.org/10.35139/cantilever.v10i2.107

Nopsagiarti, T., Okalia, D., Marlina, G. (2020). C-organic, nitrogen and C/N analysis of soil in Beken Jaya agro-tourism field. *Journal of Agroscience and Technology*, *5*(1), 11–18.

Prabowo, R., & Renan, S. (2017). Soil Analysis as an indicator of fertility level in agricultural cultivation land at Semarang City. *Cendikia Eksakta Scientific Journal*, *2*(2), 59–64.

Pribadi, A. A., Hastuti, P. B., Santosa, T. N. B. (2016). Effects of lime dosage on the nodulation of several types for legume cover crop in peat soil. *Journal of Agromast*, *1*(2), 1–12.

Rachmadiyanto, A. N., Wanda, I. F., Rinandio, D. S., Magandhi, M. (2020). Evaluation of soil fertility in various land covers at Bogor Botanic Gardens. *Botanical Garden Bulletin*, *23*(2), 114–125. https://doi.org/10.14203/bkr.v23i2.263

Rahmi, A., & Biantary, M. P. (2014). Characteristic of soil chemical properties and soil fertility status at the home yard and farm lands in several villages of West Kutai District. *Journal of Ziraa'ah*, *39*(1), 30–36.

Sari, V. F., Ekawita, R., Yuliza, E. (2021). Arduino Uno-based Digital Soil pH Build Design. *Journal Online of Physics*, *7*(1), 36–41. https://doi.org/10.22437/jop.v7i1.14589

Sipahutar, A. haloman, Marbun, P., Fauzi. (2014). Study of C-Organic N, and P of Humitropepts at different altitude in sub-district of Lintong Nihuta. *Agroecotechnology Online Journal*, *2*(4), 1332–1338.

Soewandita, H. (2018). A study of water management and palm oil productivity in peatlands (Case Study: Peatlands of PT Jalin Vaneo's Palm Plantation in North Kayong District, West Kalimantan Province). *Journal of Weather Modification Science and Technology, 19*(1), 41–50. https://doi.org/10.29122/jstmc.v19i1.3112

Soil Research Center. (1983). Chemical Analysis of Soil, Plants, Water, and Fertilizers. *Department of Agriculture.*Bogor.

Tarigan, E. S. B., Guchi, H., Marbun, P. (2015). Evaluation status of organic matter and soil physical properties (BulkDensity, Texture and Soil Temperature) the coffee crop land (*Coffea* Sp.) in Some Districts Dairi. *Journal of Agroecotechnology, University of North Sumatra*, *3*(1), 246–256. https://doi.org/10.32734/jaet.v3i1.9474

Tewu, R. W. G., Theffie, K. L., Pioh, D. D. (2016). Study of soil physical and chemical properties in sandy soil in Noongan village, Langowan Barat Sub-District. *In Cocos*, *7*(2), 1–8.

Umaternate, G. R., Abidjulu, J., Wuntu, A. D. (2014). Olsen and bray method test in analyzing available phosphate content in rice field soil at West Konarom Village, North Dumoga District. *Journal of MIPA*, *3*(1), 6–10. https://doi.org/10.35799/jm.3.1.2014.3898

Virmanto, D., Sa'ad, A., AR, A., Ermaandi. (2022). Study of some characteristics of peat soil on burned and unburned land in oil palm plantations. *Journal of Soil and Land Utifization Management*, *19*(2), 43–52.

Wasis, B., Saharjo, B. H., Waldi, R. D. (2019). Impact of forest fire on flora and mineral soil properties in forest area of Pelalawan District, Riau Province. *Journal of Tropical Silviculture*, *10*(1), 40–44. https://doi.org/10.29244/j-siltrop.10.1.40-44

Winingsih, A., Abraham, S., Mulyani, O., Nurbaity, A., Trinuranisofyan, E. (2019). The role of hydrogel and incubation time towads pH, C-Organik and N-Total Soil. *Journal of Science and Technology Research*, *24*(1), 46–54.