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Classification of Inceptisol Soil on Robusta Coffee Plantation in *Silima Pungga – Pungga* District

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Abstract

The survey study aims to classify the Inceptisol soil on Robusta coffee plantation in Silima Pugga-Pungga District, from Order level to Sub Group level. The study was conducted on location of sample soil profiles which were determined based on Soil Map Unit (SMU) with the main Inceptisol Order, i.e. from SMU 3 to SMU 7. The soil profiles were described to determine the morphological characteristics of the soil, while the physical and chemical properties were done by laboratory analysis. The soil samples were taken from each horizon in each profile and analyzed in the laboratory in the form of soil texture, bulk density, pH H_2O, pH KCl, C-organic, Bases Exchange (Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}) and Cation Exchange Capasity (CEC). The results showed that the classification of Inceptisol soil on Robusta coffee plantation in Silima Pungga-Pungga District based on Soil Taxonomy 2014 has 2 (two) Sub Group, namely in SMU 3,4,5 and 7 are Typic Humudept and SMU 6 is Fluventic Humudept.

Keywords: Soil Classification; Inceptisol; Robusta Coffee.

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1. Introduction

Inceptisol soil is belonged to the order of soil which has a wide spread in Indonesia. According to Hardjo, this kind of soil is found in land area about 70.52 million hectare or 37.5% of the total land area in Indonesia [1: 21-66]. Furthermore, Kasno stated that this soil is a potential soil types to be developed [2: 111-118]. Based on the wide and potential spreading of Inceptisol soil, the development of this land in the future has an economic value.

This soil is commonly called young soil since its formation profile is rather slow. Some of the factors that influence its formation are the basic material that is resistant to weathering and has a steep slope relief. This soil usually has a basic material of igneous, sedimentary and metamorphic stone. The land area textures are usually formed of wavy to hilly land. In the lowlands generally have thick solum, meanwhile the highlands have shallow solum. According to the Soil Survey Staff, the central concept of Inceptisol soil is the soil are cold or very hot, humid, sub-humid and have kambik horizon and epipedon umbrik or molik [3:38-41]. This soil properties information helps to classify into the standard soil classification system, so that it can provide early knowledge in the management of these lands. Coffee is the second most important commodity export in the global trade after the petroleum. According to Amsalu and his colleagues coffee contributed (in a great deal) for Indonesia's economy, as a foreign exchange earner, income source for farmers, produce raw materials for other industrial sector, create job vacancies and regional development [4: 1-12]. According to Dinas Perkebunan Provinsi Sumatera Utara; in North Sumatera Province, there are several Robusta coffee farming districts, one district that became the center of Robusta coffee production is Dairi. Meanwhile, Silima Pungga Pungga is one of sub-district in Dairi that has the highest production and productivity rate of Robusta coffee. The production rate is around: 467 ton and 610.46 ton/ha/year. However, the productivity rate of Robusta coffee in these districts is still low. It is still far from the potential of Robusta coffee production to reach 2.30 to 4.0 ton/ha/year [5: 1-10]. The soil naming, in this case refers to the soil classification system developed by the USDA in 1975 known as Soil Taxonomy. The classification system is still developing with the recent update in 2014 with a lot of additional content in the soil nomenclature category. Based on description above, the author is interested in conducting a research that aims to identify the classification of Inceptisol soil in Robusta coffee plantation in the sub-district of Silima Pungga Pungga based on Keys To Soil Taxonomy 2014. It is expected that the results of this study can give precise information for soil classification to a better farming, especially for Robusta coffee plantation in Silima Pungga Pungga.

2. Research methodology

2.1. Research place and time

This research was conducted on Robusta coffee plantation in Sub-district of Silima Pungga Pungga, Dairi district ($2^0$15' - $3^0$00' North Latitude and $98^0$00' - $98^0$30' South Latitude), with a height of 400 to >800 meters above sea level. Soil analysis is conducted at the Faculty of Agriculture's Research & Technology Laboratory, University of North Sumatera.

2.2. Research tools and materials

Tools and materials which used in this research are; administration map, soil types map, land altitude map, land slope map, Soil Map Unit (SMU) of Silima Pungga Pungga Sub-district with scale of 1: 25,000 for each map, soil samples from each layer profile, GPS (Global Position System), the meter, Munsell soil Color Chart book, ring sample to take undisturbed soil sample, camera, profile description form, rainfall and air temperature data, plastic bags, scout knives, hoes and labels.

2.3. Research implementation

This research used survey method (field observation) to determine the morphology and characteristics of the soil, in order to classify the soil from Order to Sub-group level according to Keys To Soil Taxonomy 2014. The procedures of this research were divided into five stages, namely: secondary data collection, field observation, soil sampling, soils analysis and reports compilation. Soil profile center location (pedon) is determined by the secondary data from Soil Map Unit (SMU) which obtained from the overlay result between soil type map, land altitude map and land slope map with the scale of 1: 25,000 for each map. Land drilling is done at some point which represents each SMU, then decided the soil profiles location which representing (as representative) for further observation. Field observation is carried out on the soil profile by digging the soil to a maximum depth (solum soil). This activity is to characterize the soils which indicate properties and characteristics of soil morphology that would be observed such as: horizon limitation or soil layer, soil color, soil texture, soil structure, soil consistency and effective depth. Undisturbed and disturb soil samples intact are performed at each horizon or layer soil and analyzed in the laboratory. At the time of soil sample intact, researcher also recorded the field data research areas, included: vegetation, physiographic, drainage, altitude, slope, geography and land use. The soil samples were taken and then analyzed in the laboratory. Analysis of soil physical characteristics and soil texture was conducted using hydrometer method, soil color and soil density were conducted using ring method. Analysis of the chemical characteristics of the soil with pH H_2O and pH KCl were conducted using electrometric methods, levels of C-organic was conducted using Walkley and Black method, Bases Exchange (Ca, Mg, K, and Na) with extraction of NH_4OAc pH 7 1N, the Cation Exchange Capacity (CEC) with the extraction of NH_4OAc pH 7 1N. The data results of field and laboratory research were used for soil classification based on the Keys To Soil Taxonomy 2014. The stages of soil classification are as follows: (1) Determining of main horizon and sub horizon symbols, (2) Determining of the surface horizon identifier, (3) Determining of the sub surface horizon identifier, (4) Determining of other identifiers, (5) Determining of the soil Order, (6) Determining of Sub Order, (7) Determining of Great Group and (8) Determining of the Sub Group.

3. Result and discussion

Inceptisol soil order found in SMU 3 to SMU 7 from 18 SMU planted with Robusta coffee in Silima Pungga Pungga. Soil order, land slope and altitude, villages' name and the width of SMU 3 to SMU 7 can be seen from this Table 1 below.

Table 1: Soil order, land slope, land altitude, villages' name and the width of SMU 3 to SMU 7.

SMU	Soil Type	Land Altitude (meter - above sea level)	Slope (%)	Villages' name	Area (ha)
SMU 3	Inceptisol	400 – 500	0 – 4	*Lae Panginuman*	167.21
SMU 4	Inceptisol	400 – 500	8 – 16	*Lae Panginuman*	113.56
SMU 5	Inceptisol	500 – 600	0 – 4	*Lae Ambat, Lae Panginuman*	409.39
SMU 6	Inceptisol	500 – 600	8 – 16	*Lae Panginuman, Bakal Gajah*	126.47
SMU 7	Inceptisol	500 – 600	16 – 30	*Lae Ambat, Lae Panginuman*	75.36

Based on the field observation, it can be seen that there are some differences and similarity characteristics and properties of the soil between some of the Inceptisol soil. Therefore, the soil classification location for the research resulting; only two from five soils profile that were discussed, they are: (1). SMU 3 profile also represent SMU 4, 5, dan 7 profile. (2). SMU 6 profile.

3.1. Soil morphology

The soil color for SMU 3 profile and others are from light brown (7.5 YR 6/4) to reddish yellow (7.5 YR 6/8); meanwhile, SPL 6 profile is from dark brown (10 YR 3/3) to yellowish brown (10 YR 5/6). The increasing of soil color is in accordance with the increasing of the soil depth. The deeper it is, the soil color will brighten due to the decreasing of organic content in lower horizon. The differences in color of each *pedon* tend to lie on the number of *value* and *chroma*. Soil structure on surface horizon is generally soft because the influence of tillage and organic matter. On the other hand, sub surface horizon is dominated by soft to solid soil structure. The state of this structure is supported also from the analysis of bulk density, whereas a solid structure relatively has higher bulk density point. Upper horizon consistence is generally friable and some profiles will be more resolute deeper. Besides influenced by the clay content, soil consistency is also influenced by the activity of roots and organic matter.

3.2. Soil physical properties

Color, structure and consistency are soil physical properties which observed in the field. While soil texture and bulk density are analyzed in the lab. The soil physical properties of SMU 3 and SMU 6 can be seen in Table 2 are as follows.

3.3. Soil chemical properties

The soil chemical properties which analyzed in the laboratory are; pH H_2O, pH KCl, Bases Exchange, Cation Exchange Capasity (CEC), Base Saturation (BS), P-available, C-organic and Electrical Conductivity. These analyses can be seen in Table 3 below.

Table 2: Morphology and analyses of soil physical properties at SMU 3 and SMU 6 profile

Profile Soil	Horizon	Soil Depth (cm)	Color	Structure	Consistency		Texture (%)			Texture Class	Bulk Density (g/cm^3)
					Moist	Wet	Sand	Silt	Clay		
SPL 3	Ap	0 – 37/22	7.5YR 6/4	c	friable	ss	57.84	24,56	17.60	sl	1.15
	B	37/22 – 54/41	7.5YR 6/6	c	friable	ss	53.84	18.56	27.60	scl	1.20
	C	54/41 – 150	7.5YR 6/8	b	friable	ss	53.12	17.28	29.60	scl	1.25
SPL 6	Ap	0 – 33/36	10YR 3/3	c	friable	ss	57.48	22.92	19.60	sl	1.19
	AB	33/36 – 62/83	10YR 5/3	b	friable	s	33.12	27.28	39.60	cl	1.22
	C	62/83 – 150	10YR 5/6	b	firm	vs	41.12	17.28	41.60	c	1.24

Notes : structure: c = crumb
b = blocky

consistency: ss = slightly sticky
s = sticky
vs = very sticky

texsture: sl = sandy loam
scl = sandy clay loam
cl = clay loam
c = clay

Table 3: Analyses result of soil chemical properties at SMU 3 and SMU 6 profile

Soil Profile	Horizon	Soil Depth (cm)	pH		Base Saturation (%)	Adsorption Complex (me/100g)					C-org (%)	P-available (ppm)	EC (dS/m)
			pH H_2O	pH KCl		CEC	Ca	Mg	K	Na			
SMU 3	Ap	0 – 37	5.00	3.69	12.16	17.43	0.354	1.308	0.139	0.319	1.82	9.70	0.70
	B	37 - 54	4.84	3.56	3.15	97.68	2.436	0325	0.114	0.205	1.33	11.19	0.65
	C	54 - 150	5.23	5.16	19.05	14.43	1.669	0.200	0.329	0.332	1.24	10.45	12.39
SMU 6	Ap	0 – 36	5.85	4.93	17.08	15.43	0.913	1.337	0.126	0.260	1.59	6.87	1.05
	B	36 -83	4.10	3.55	22.40	18.87	1.749	2.182	0.172	0.124	0.45	14.78	0.85
	C	83 -150	4.82	3.58	10.92	10.99	0.666	0.336	0.063	0.135	0.68	14.93	0.35

3.4. Determination of surface horizon identifier (epipedon)

Epipedon soil identifier on soil surface layer for SMU 3 and SMU 6 and is *epipedon umbrik*. Terms for *epipedon umbrik* are the position located above the soil, has a color *value* and *chroma* of 3 or less (humid), base saturation <50% and moist soil in a state of more than 3 months.

3.5. Determination of sub surface horizon identifier

Kambik horizon is found on SMU 3 and SMU 6, because it has a very fine sand texture called *sandy loam*, horizon thickness is more than 15 cm, the absence of clay *illuviasi* process and is not part of the Ap horizon, also did not experience the aquatic condition.

3.6. Determination of other identifier

SMU 3 and SMU 6 have a moisture regime *udik*, because the soil never dries within 90 days (cumulative), more than 90 days or from the data obtained by the average rainfall in the wet season range from 7-10 months per year or 210 days to 300 days (cumulative), and has soil temperature regime *isohipertermik*, because the hottest and coldest temperature variation is smaller than 6^0C, it is $0,30^0$C. As well as the annual soil temperature average is greater than 22^0C, it is $22,49^0$C.

3.7. Order determination

SMU 3 and SMU 6 belong to Inceptisol Order, because they have *epipedon umbrik* and sub surface horizon identifier is found at a depth of less than 100 cm of the soil surface.

3.8. Sub order determination

SMU 3 and SMU 6 belong to Sub Order *Udept*, because they have soil moisture regime *udik*.

3.9. Great group determination

SMU 3 and SMU 6 belong to Great Group *Humudept*, because they have *epipedon umbrik*.

3.10. Sub group determination

SMU 3 belong to Sub Group *Fluventic Humudept*, because it has a slope of less than 25%, has an organic carbon content of more than 0.2% and has a decreasing of organic carbon regularly at a depth of 25-125 cm.

SMU 6 belongs to *Typic Humudepts*, because it is another *humudepts*.

4. Conclusion

1. Classification of SMU 3, 4, 5 and 7 soils are: Order; Inceptisol, Sub Order; Udept, Great Group;

Humudept and Sub Group; Fluventic Humudept.

2. Classification of SMU 6 soil is: Order; Inceptisol, Sub Order; Udept, Great Group; Humudept and Sub Group Typic Humudept.

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