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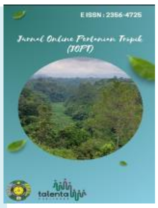

Soil Quality Evaluation of Inceptisol Based on the Alberta Card (Case Study of Horticultural Land in Titi Papan, Medan Deli District)

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ABSTRACT

Soil quality describes the suitability of the physical, chemical, and biological properties of soil that together function as a medium for plant growth. The Alberta Soil Quality Card is one method for evaluating soil quality through soil quality indicators, such as organic matter content, drainage, water-holding capacity, soil microorganisms, and erosion. This research was conducted to evaluate the Inceptisols soil quality of horticulture land in Titi Papan, Medan Deli District, based on the indicators listed in the Alberta Soil Quality Card to obtain appropriate soil management recommendations based on the evaluation results. The results of observations of soil quality on the Titi Papan horticultural land in Medan Deli District show that the indicators of plant/weed strength, germination, soil fertility and salinity are included in the preferred score, the indicators of residual surface, drainage/infiltration, aggregation, soil life/earthworms, compaction are included in the medium score while the main inhibiting factor is water holding capacity (low score). Horticultural land in the Titi Papan area, Medan Deli District, requires effective water management for each growth phase.

Keywords: soil quality, Alberta card. Land, Horticultural

ABSTRAK

Kualitas tanah menggambarkan kesesuaian sifat-sifat fisik, kimia dan biologi tanah yang secara bersama-sama berfungsi sebagai media untuk pertumbuhan tanaman. Kartu kualitas tanah Alberta merupakan salah satu metoda untuk mengevaluasi kualitas tanah melalui indikator kualitas tanah, seperti kandungan bahan organik, drainase, kapasitas tanah air, mikroorganisme tanah dan erosi. Penelitian ini dilakukan untuk mengevaluasi kualitas tanah Inceptisol pada lahan hortikultura di Titi Papan Kecamatan Medan Deli berdasarkan indikator-indikator yang tercantum pada kartu kualitas tanah Alberta untuk memperoleh rekomendasi pengelolaan tanah yang tepat berdasarkan hasil evaluasi. Hasil observasi kualitas tanah pada lahan hortikultura Titi Papan Kecamatan Medan Deli menunjukkan bahwa indikator kekuatan tanaman/gulma, perkecambahan, kesuburan tanah dan salinitas termasuk dalam skor disukai, indikator permukaan residu, drainase/infiltrasi, agregasi , kehidupan tanah/cacing tanah, pemadatan termasuk ke dalam skor medium sedangkan faktor penghambat utama adalah kapasitas menahan air. Lahan hortikultura di wilayah Titi Papan, Kecamatan Medan Deli membutuhkan pengelolaan air yang efektif untuk tiap fase pertumbuhan.

Kata kunci : *kualitas tanah, kartu Alberta. Lahan. hoticultura*

1. Introduction

Soil quality is a reflection of the response to increasing pressure on sustainable land use with a holistic focus that emphasizes that sustainable land management requires more than just controlling erosion. Soil quality describes the suitability of physical, chemical, and biological properties of soil that together function as: a medium for plant growth and biological activity, regulation and division of water flow and its storage in the environment, and an environmental buffer against destruction by harmful compounds (Ayuningtias et al., 2016). Good soil quality affects the improvement of production yield, whereas inappropriate management systems lead to a decline in land productivity, resulting in suboptimal crop production. Poorly functioning soil causes a decrease in soil quality (Arthagama and Dana, 2020) and soil fertility (Sumarniasih & Antara, 2021).

The quality of the soil significantly influences the increase in production yields, whereas improper management systems lead to a decline in land productivity, resulting in suboptimal crop production. Soil that does not function properly causes a decrease in soil quality (Arthagama & Dana, 2020) and soil fertility (Sumarniasih and Antara, 2021). Assessing soil quality includes physical, chemical, and biological properties of the soil; furthermore, factors such as soil type, land use type, and topography are primary considerations that must be taken into account in assessing soil quality for the purpose of developing the agricultural and plantation sectors (Suleman et al., 2016). Soil indicators play an important role in determining soil quality (Sholeye et al, 2021). The interaction between soil and plants is greatly influenced by soil bacteria, which are also crucial for maintaining soil quality. Assessing soil quality is important for the development of performance and evaluation of sustainable land and soil management systems. Continuous land use (1 - 5 years) necessitates the need to assess current soil quality conditions and record changes in soil quality, identify potentially problematic areas, and provide measures of soil quality to compare land and management practices.

Soil quality card is a simple and non-technical method for assessing soil quality in the field and is subsequently used as a recommendation for making appropriate management decisions. The soil quality card uses indicators and descriptions that are rational against agricultural levels and measures soil quality qualitatively. It allows for soil quality to be assessed without the use of technical equipment or laboratories. The Alberta Soil Quality Card provides a systematic approach to assessing various indicators of soil quality, such as organic matter content, drainage, water holding capacity, soil macroorganisms, and erosion. Soil quality evaluation is also used to assess agricultural practices (AESA Soil Quality Monitoring Program, 2003). The method using the Alberta Quality Card is one of the land quality assessment approaches that considers various physical, chemical, and biological parameters of soil in an integrated manner. This method allows for a holistic assessment to determine land suitability for specific crops (Zhang et al., 2020). Inceptisols the develop from volcanic materials have characteritics of clay conten ≥ 40% and has a homogeneous matric color, deep soil cross section (Subardja et al., 2016) and would have a clay loam to clay texture (Hardjowigeno, 1993). According Shamsduddin and Kapok (2010) basalt-based soils have relatively better fertility since they have a pH close to neutral because basalt has ability to increase soil pH as well as lime. This study aims to evaluate the quality of Inceptisol in horticultural land in Titi Papan, Medan District, Deli Serdang Regency, using the Alberta soil quality card. It is hoped that the results of this study will yield appropriate recommendations for better land management, support local agricultural productivity, and maintain the sustainability of soil ecosystems in the horticultural land.

2. Methods

This research was conducted at Main Citra Park Road, Titi Papan, Medan Deli District, Medan City, North Sumatra Regency (see Figure 1) in December 2024. The soil in this area is classified as Inceptisol and is planted with vegetables (spinach and water spinach) with a crop rotation of up to 2-3 times from the initial planting type. Soil management in this area is carried out using hoes. The fertilizers applied include Urea, SP-36 and KCl. Organic fertilizer provided consists of duck manure fertilizer (1 bucket/beds). The harvest results of spinach and water spinach obtained previously are 30 bales per harvest and 50-60 bales per harvest. This study was conducted using a qualitative descriptive method based on the Alberta soil quality card. The soil samples that were observed were randomly set to 5 sample points for each indicator. The percentage of the most common observations for each indicator is designated as a selected score, and the observation results are adjusted according to the ranking and then scored (see Table 2).

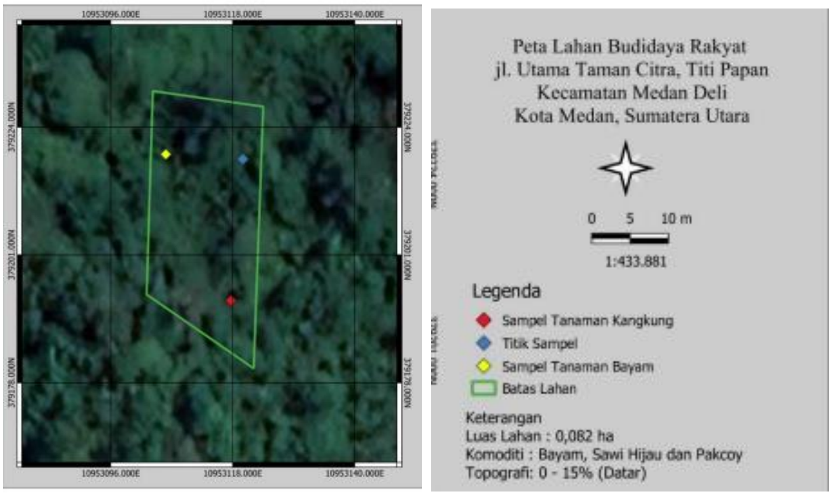

Figure 1. Map of the soil observation location in the horticultural land of Titi Papan, Medan Deli District

The stages of soil quality assessment using the Alberta quality card based on the AESA Soil Quality Monitoring Program (2003), with the following steps:

1. Prepare writing tools and a shovel
2. Set the appropriate time to assess each indicator (see Table 1)

Table 1. Soil quality assessment schedule

Indicator	Ranking			Score		
	Low (L)	Medium (M)	Prefered (P)			
Crop/Weed Vigor	Stunted growth, uneven stand, consistently poor yields	Some uneven or stunted growth, inconsistent yields	Healthy, vigorous and uniform stand, consistently good yields	L	M	Ⓟ
Residu cover	Little or no surface residue, bare soil present	Some surface residue present, but soil surface not completely covered	Soil surface covered year round, little bare soil present	L	Ⓜ	P
Organic matter color	Topsoil color similar to subsoil	-	Tehe top soil is clearly defined as darker than the subsoil	Ⓛ	M	P
Drainage/ infiltration	Soil absorbs water very slowly, lots of runoff or erosion, excessive wet spots in field, ponding	Soil absorbs water slowly, some runoff or erosion, some wet spots in field and soil profile	Soil absorbs water quickly, very little runoff or erosion, water is evenlydrained through field and soil profile	L	Ⓜ	P
Water holding capacity	Soil has limited capacity to hold water, plant stress a couple days after a good rain	Soil has moderate capacity to hold water, water runs out after a week or so	Soil holds water well, holds water for a long period of time with-out ponding	Ⓛ	M	P
Agregation	Soil surface is hard, clumps and does not break apart, very powdery when dry	Soil crumbles in hand, few aggregates	Soil surface has many soft small aggregates which crumble easily	L	Ⓜ	P

Earthworms/soil live	Very few worms, insects or visible soil life per shovel. Little evidence ofactivity (holes or worm casts)	Some worms, insects and other visible soil life per shovel, some evidence of activity	Many worms, insects or visible soil life per shovel	L Ⓜ P
Compaction/rooting	Hard layers, severely restricted root penetration, very few roots, mostly Horizontal	Firm soil, slightly restricted root penetration, more roots, some horizontal and some remaining vertical	Loose soil, unrestric-ted root penetration, many vertical and horizontal roots, deep rooting	L Ⓜ P
Crusting/ Emergence	Soil surface seals easily after tillage or rain, seedling emergence inhibited	Some surface sealing, minimal effect on seedling emergence	Soil surface has open or porous surface all season, seedling emergence not affected	L M Ⓟ
Tilth/ Workability	Crusting, large clods, tills with difficulty	Some crusting, small clods, medium pull	Mellow, crumbly, tills easily, leaving no clods	L M Ⓟ
Salinity	Visible salt, dead plants	Stunted growth	No visible salt or plant damage noted	L M Ⓟ

Source *:* AESA Soil Quality Monitoring Program (2003)

3. Divide the field or area into separate parts for evaluation based on soil type, topography, land management, crop rotation, and management practices
4. Complete the field identification and management notes on the Alberta soil quality card with information regarding the field or area being assessed
5. Rate each indicator based on the assessment of the soil and circle the rating that most accurately describes the soil condition
6. Monitor changes in each indicator over time, noting indicators that need improvement and considering management options that may enhance soil quality in the area. To obtain the most effective qualitative assessment results, evaluation should be conducted consistently by the same person over time and under similar field conditions and from more than one point to achieve more accurate results. Indicator assessment does not represent absolute size or value but evaluates each land's ability to function within its environment.

Table 2. Soil Quality Assessment in Horticultural Land Based on the Alberta Soil Quality Card

Indicator	The most appropriate time to assess
Crop/Weed Vigor	during growing season
Residu cover	anytime
Organic matter color	anytime with moist soil conditions
Drainage/infiltration	anytime or after rainfall
Water holding capacity	during growing season after rainfall
Agregation	anytime
Earthworms/soil live	spring or fall, with moist soil conditions
Compaction/rooting	during growing season with moist soil
Crusting/Emergence	during spring after a rainfall event
Tilth/Workability	spring or late fall with moist soil
Water/wind erosion	after a high sustained wind/rainfall
Salinity	during growing season, 30 days after emergence

Source *:* AESA Soil Quality Monitoring Program (2003).

3. Result and Discussion

Based on the interview results with Mr. Sumiadi, it is known that the harvest data includes 30 bundles of spinach and 50-60 bundles of water spinach per planting. The harvest results tend to be consistent (see Table 2) each year, and he has been running this horticultural cultivation business for 10 years. Peformance of spinach and water spinach at location research is healthy, vigorous and uniform stand, consistently good yields (preferred score). Based on the land distribution map, it is known that the soil in that area belongs to the Inceptisol order with crumbly and easily crumbling aggregate structure (medium score for aggregation indicator). Spinach requires loose soil that contains a lot of organic material. The suitable soil pH for spinach plant growth ranges from 6 to 7 (Bandini and Nurudin, 2004). As according Shamsduddin and Kapok (2010) that Inceptisol basalt-based have relatively better fertility since they have a pH close to neutral because basalt has ability to increase soil pH as well as lime. This condition is influenced by the habits of farmers who routinely add manure from duck droppings when cultivating the land, thereby increasing the fertility and quality of the soil. In accordance with the opinion of Yunanda et al. (2022), animal manure can improve various factors of soil fertility, including increasing nutrient content, humus, and improving soil structure. Some surface residue present, but soil surface not completely covered (medium score).

In the area between the beds, the topsoil layer has a color similar to the bottom layer (low score). This condition is likely caused by channel erosion at several points in the land. Channel erosion results in the topsoil layer being carried away (medium score), which directly impacts the loss of nutrients and the fertile soil layer essential for root growth. In addition, the indirect impacts of erosion include siltation and sedimentation of reservoirs, ecosystem damage, deteriorating water quality, increased frequency of droughts, and the burial of agricultural land (Hartono, 2016). In this land, the most significant impact is that soil material carried by rainwater settles in the drainage channels, causing the water to become murky and leading to siltation of the channels. If this condition is not addressed promptly, it may reduce the efficiency of the drainage system and increase the risk of waterlogging which falls into the preferred score category (see Figure 2).

Figure 2. Channel erosion and waterlogging

Based on the interview results, Mr. Sumiadi stated that during the rainy season with high rainfall, the land often experiences waterlogging that takes time to recede. This indicates that the soil's ability to absorb water is relatively slow. Although the soil has a granular structure, when wet, it tends to compact, which hampers water infiltration. Nevertheless, the soil in the area has a fairly good capacity to retain water. This is evidenced by the farmers' acknowledgment that they do not need to irrigate during the rainy season, and during the dry season, irrigation is only done in the morning (medium score). The presence of macrofauna such as earthworms and ants is clearly visible in the area, which falls into the preferred score category. This is indicated by the abundance of earthworm castings and ant holes scattered on the surface of the land (see Figure 2).

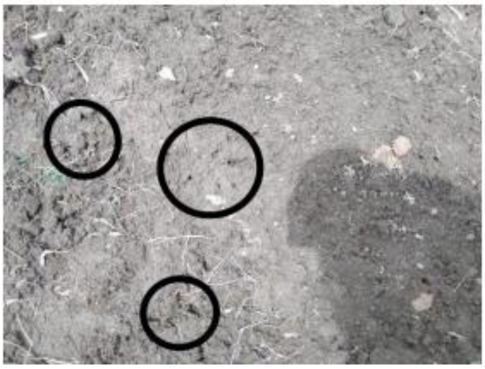

Figure 2. Worm droppings and ant holes

According to Ramadhanti et al. (2023), earthworms serve as bioindicators because their activities break down organic matter, making them very sensitive to soil pollutants. The presence of this macrofauna not only reflects good biological activity but also indicates that the soil is non-saline (preferred score). Another reason supporting this is the absence of seawater intrusion into the area, given that the land is not located near coastal areas or the seaside. This condition indicates that the soil environment supports the life of organisms and plant productivity. Based on the observation of soil quality assessment from various indicators, the soil in that area overall has quite good quality. However, there are several limiting factors that need to be considered, such as the low rate of water infiltration and the occurrence of erosion in some areas. To address these issues, efforts to improve soil organic matter, the use of green fertilizers, and the reduction of soil tillage frequency are needed to decrease soil compaction. Tillage using a hoe helps to loosen the soil and maintain its porosity, thereby supporting optimal water infiltration rates.

4. Conclusion

The results of observations of soil quality on the Titi Papan horticultural land in Medan Deli District show that the indicators of plant/weed strength, germination, soil fertility and salinity are included in the preferred score, the indicators of residual surface, drainage/infiltration, aggregation, soil life/earthworms, compaction are included in the medium score while the main inhibiting factor is water holding capacity (low score). It is recommended to increase the use of manure or compost to improve organic matter content. The presence of channel erosion poses a minor obstacle, so conservation practices such as planting cover crops, implementing minimum tillage, and adding organic matter need to be conducted. Regular evaluations of soil quality in the horticultural land are highly recommended to monitor changes and assess the effectiveness of the management practices applied.

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