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Analysis of Chemical and Physical Soil Fertility on Maize (*Zea mays* L.) Cultivated Land in Telaga Biru District, Gorontalo Regency, Indonesia

Adriyanto Rahman[1], Zulzain Ilahude[2], Silviana Arsyad[3], Nurmi[4], Rival Rahman[5]

[1] Department of Agrotechnology, Faculty of Agriculture, Gorontalo State University, Indonesia
[2,3,4,5] Agrotecnology Lecturer at Gorontalo State University.Gorontalo.Indonesia

Corresponding Author: adriyantorahman085@gmail.com

Abstract

Maize (Zea mays L.) is a significant food commodity in Telaga Biru Subdistrict, Gorontalo Regency; therefore, information on soil fertility is crucial as a basis for effective land management. This study aims to analyze the chemical and physical fertility of soils in maize cultivation areas and to identify efforts to improve maize productivity in Telaga Biru Subdistrict. The study was conducted from April to November 2025 in Telaga Biru Subdistrict, Gorontalo Regency. A descriptive quantitative method with a land unit-based survey approach was employed. Soil sampling was conducted diagonally in three villages: Timuato, Modelidu, and Talumelito, at a depth of 0-20 cm. The analyzed chemical fertility parameters included soil pH, nitrogen, organic carbon, cation exchange capacity, available phosphorus, potassium, and base saturation. Physical soil properties analyzed included soil texture, bulk density, and soil color. The findings showed that the soil pH was slightly acidic, with nitrogen and organic carbon contents falling into the low to moderate categories. The cation exchange capacity and the availability of phosphorus and potassium were moderate, while base saturation was relatively low: The physical soil properties were dominated by clay to clay loam textures with relatively high bulk density values. These conditions indicate that maize cultivation land in Telaga Biru Subdistrict has sufficient fertility to support plant growth; however, appropriate soil management is still required through balanced fertilization, the addition of organic matter, and improvement of soil physical properties to enhance productivity sustainably.

Keywords: soil fertility, soil chemistry, soil physics, maize, Telaga Biru.

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INTRODUCTION

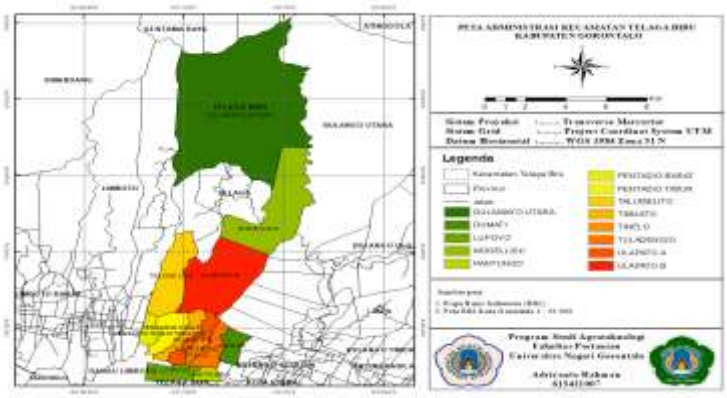
Maize (Zea mays L.) is one of the most important food crops in Indonesia and plays a strategic role in national food security. In Gorontalo Province, maize cultivation continues to expand, including in Telaga Biru District, which is recognized as a major maize-producing area. However, maize productivity in this region has not yet reached optimal levels due to variations in soil quality and land management practices (Widodo Herukoko & Kusuma Zaenal, 2018).

Soil fertility is determined by the interaction of chemical and physical soil properties that regulate nutrient availability, root development, and soil biological activity (Cahyo Tri et al., 2013). Chemical properties such as soil pH, organic carbon, nitrogen, phosphorus, potassium, cation exchange capacity, and base saturation strongly influence nutrient retention and uptake by plants (Siswanto, 2018). Meanwhile, physical properties including soil texture, bulk density, and structure affect water retention, aeration, and root penetration (Tamara et al., 2020).

Several studies have reported that maize cultivation land in tropical regions is commonly characterized by low organic matter content, acidic to slightly acidic soil reaction, and low base saturation, which limit crop productivity (Harista & Soemarno, 2017; Sriwahyuni et al., 2025). Therefore, a comprehensive analysis of soil chemical and physical fertility is required as a basis for sustainable land management. This study aimed to evaluate the soil fertility status of maize cultivation land in Telaga Biru District, Gorontalo Regency.

METHOD

This study was conducted from April to November 2025 in Telaga Biru District, Gorontalo Regency, Indonesia. Soil sampling was carried out in three villages, namely Timuato, Modelidu, and Talumelito, using a diagonal sampling method. Composite soil samples were collected from five sampling points at a depth of 0–20 cm, while undisturbed soil samples were obtained using ring samplers for bulk density analysis.



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Chemical soil analyses included measurement of soil pH (H_2O), total nitrogen using the Kjeldahl method, organic carbon using the Walkley and Black method, available phosphorus using the Olsen method, exchangeable potassium, cation exchange capacity, and base saturation using ammonium acetate extraction at pH 7.0. Physical soil properties analyzed included soil texture using the hydrometer method, bulk density using the gravimetric method, and soil color determined using the Munsell Soil Color Chart. Data were analyzed descriptively and interpreted based on national soil fertility classification criteria (Hardjowigeno, 2010).

RESULTS AND DISCUSSION

Variations in total nitrogen and organic carbon among the sampling sites reflect differences in organic matter inputs and land management practices. Soils from Timuato Village showed relatively higher organic carbon and nitrogen contents, indicating more effective residue retention and lower nutrient losses. Soil organic matter is a key determinant of soil fertility, as it enhances nutrient availability, stimulates microbial activity, and improves aggregate stability. Conversely, the lower organic carbon levels observed in Modelidu and Talumelito may limit nutrient mineralization processes and reduce nitrogen availability for maize, potentially constraining crop productivity (Abdullah et al., 2023; Roslina Imran et al., 2025).

Low base saturation values recorded across all locations suggest that soil exchange complexes are predominantly occupied by acidic cations. This condition may decrease fertilizer use efficiency and restrict nutrient uptake by maize plants. Nutrients applied under such circumstances are more prone to leaching losses, particularly in areas with relatively high rainfall. Therefore, periodic liming accompanied by organic matter amendments is required to improve base saturation, increase cation exchange capacity, and stabilize soil pH (Supriyadi, 2009; Saragih & Tarigan, 2025).

From a physical standpoint, the relatively high bulk density values indicate soil compaction, likely associated with continuous cultivation and insufficient organic matter inputs. Elevated bulk density can restrict root penetration, reduce soil porosity, and limit the movement of water and oxygen within the soil profile. The application of organic amendments combined with reduced tillage practices is recommended to improve soil structure, decrease bulk density, and enhance root development and nutrient uptake efficiency (Waruwu & Buulolo, 2024; Winarso et al., 2023).

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Table I. Chemical Soil Fertility Characteristics of Maize Cultivation Land

Location	pH (H_2O)	Total N (%)	Organic C (%)	CEC (cmol(+) kg^{-1})	Available P (ppm)	Exchangeable K (ppm)	Base Saturation (%)
Timuato	6.4	0.22	2.42	21.66	14.40	14.40	33
Modelidu	6.4	0.12	1.22	14.68	11.27	11.27	29
Talumelito	6.4	0.14	1.32	17.25	11.91	11.91	30

Table II. Physical Soil Properties of Maize Cultivation Land

Location	Soil Color (Munsell)	Bulk Density (g cm^{-3})	Soil Texture
Timuato	10YR 3/1 (Very Dark Grey)	1.6	Clay loam
Modelidu	7.5YR 4/4 (Brown)	1.6	Clay
Talumelito	7.5YR 5/6 (Strong Brown)	1.7	Clay

CONCLUSION

Maize cultivation land in Telaga Biru District is characterized by slightly acidic soil reaction, low to moderate nitrogen and organic carbon contents, moderate cation exchange capacity, moderate phosphorus and potassium availability, and low base saturation. The soils are predominantly clay loam to clay with relatively high bulk density. Although these soils have moderate potential to support maize growth, improvements in soil fertility management, including balanced fertilization, organic matter addition, and soil physical improvement, are required to enhance maize productivity and ensure sustainable land use.

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