

Nurfatin Ellyana Binti Kaili

Faculty of Science & Natural Resources, Universiti Malaysia Sabah, Jln UMS
88400 Kota Kinabalu, Sabah

E-mail: nurfatin_ellyana_bs20@iluv.ums.edu.my

introduction

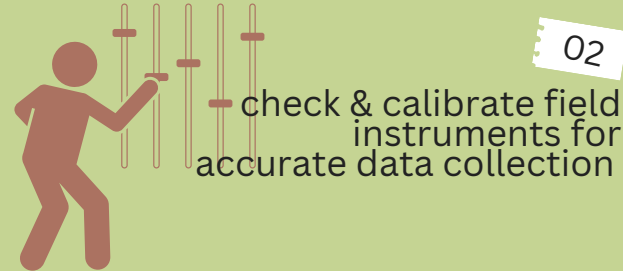
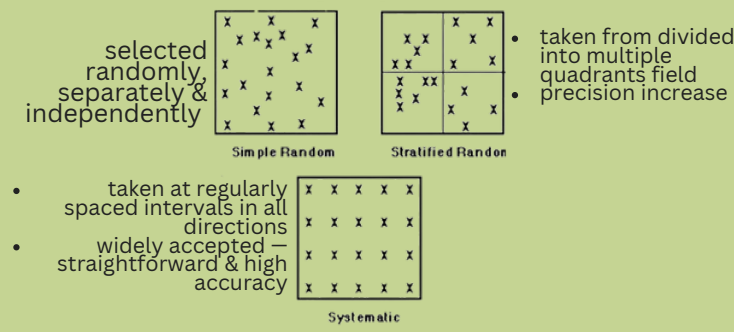
Soil is a mixture that made up of mineral particles, organic matter, water, and air (USDA, 2023) that serves both ecological and non-ecological functions (Blum, 2005). to society and environment. Soil quality testing is a process of evaluating the physical, chemical, and biological properties of soil to assess its overall health and fertility.

Soil Quality Testing a farmland analysis of



fieldwork preparation

01 obtain necessary permits & review sampling plans



pre-analysis

#1 Sample Preparation

Remove debris, stones, or plant material (Nenekmu, 2011), homogenize sample to obtain consistent representation of the tested area.

#2 Air Drying of the sample

Allow the soil sample to air dry naturally to prevent alterations in its composition, crucial to preserve initial state of the soil.

#3 Grinding the soil sample

If necessary, grind the air-dried soil to a fine consistency, this enhances uniformity and facilitates accurate testing.

#4 sieving the soil sample

Pass the soil sample through a sieve to remove coarse particles. This ensures that the analysis focuses in the finer soil fractions relevant to plant growth.

monitoring analysis

based on the objective of the testing

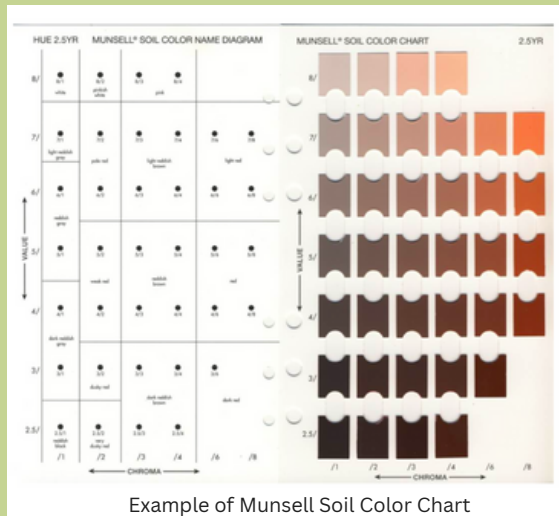
Bulk Density
Bulk density = $\frac{\text{mass of oven dry soil (g)}}{\text{volume of soil (cm}^3\text{)}}$

Porosity
Porosity = $\frac{\text{non-soil volume (cm}^3\text{)}}{\text{total volume of soil (cm}^3\text{)}}$

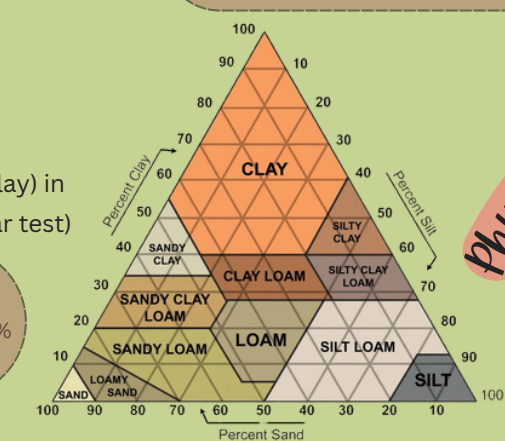
Soil Texture
composition of different particle sizes (sand, silt & clay) in the soil. there are several methods to determine: hydrometer method sieving method, feel method (jar test)

Percentage of soil particles = $\frac{\text{Hydrometer reading of soil suspension} - \text{Hydrometer reading of water}}{\text{Hydrometer reading of soil} - \text{water suspension}} \times 100\%$

Colour
Compare the soil color with standardized color chips in the Munsell Soil Color Chart - based on three main components which are hue, value and chroma



Moisture Content
Moisture content = $\frac{\text{mass of moist soil (g)} - \text{mass of dried soil (g)}}{\text{mass of dried soil (g)}}$



Soil Structure

There are several methods to evaluate soil structure:

- visual assessment
- feel method
- penetration resistance - also known as soil strength/cone index (CI)

Cone index (CI) = $\frac{\text{Applied force}}{\text{Cross-sectional area of the cone}}$

- particle size distribution - based on rate of sedimentation as well as the volume of the collected particles at specific time intervals
- image analysis - microscopy, x-ray computed tomography, digital image analysis, particle taking and segmentation

Electrical Conductivity (EC)

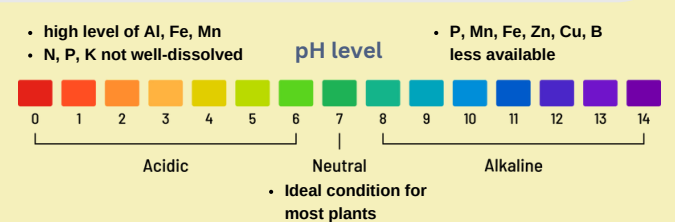
- 1. bulk electrical conductivity (ECe) - measures overall conductivity
- 2. saturated paste electrical conductivity (ECp) - measures water conductivity that extracted from soil
- use a conductivity meter - readings in decisiemens per meter (dS/m) or decisiemens per centimeter (dS/cm)

EC (dS/m)	Salinity Class
0 < 2	Non-saline
2 < 4	Very slightly saline
4 < 8	Slightly saline
8 < 16	Moderately saline
≥ 16	Strongly saline

Cation Exchange Capacity (CEC)

CEC = $\frac{\text{Volume of the solution (L)}}{\text{mass of soil (kg) \times molar mass of elements} \times 10}$

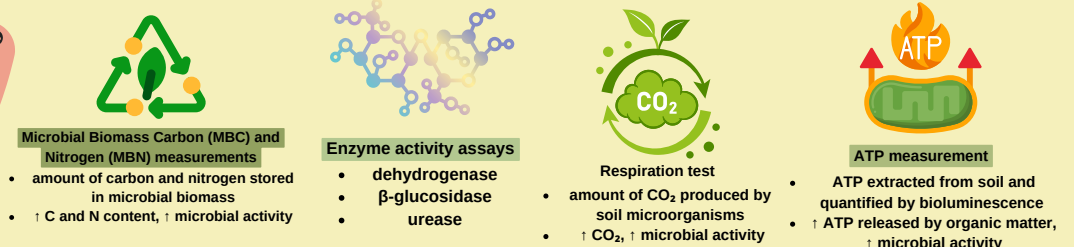
monitoring analysis



Nutrient levels

- Nitrogen - Kjeldhal method (Rajani, 2019)
- Phosphorus - Bray-P1, Olsen or Mehlich-3 methods (Culman et al, 2019)
- Potassium - Mehlich-3 method (Culman et al, 2019)
- Heavy metals - atomic absorption spectroscopy (AAS), inductively coupled plasma mass spectrometry (ICP-MS), inductively coupled plasma optical emission spectrometry (ICP-OES)

Microbial activity



Microbial Biomass Carbon (MBC) and Nitrogen (MBN) measurements

- amount of carbon and nitrogen stored in microbial biomass
- C and N content, microbial activity

Enzyme activity assays

- dehydrogenase
- β-glucosidase
- urease

ATP measurement

- ATP extracted from soil and quantified by bioluminescence
- ATP released by organic matter, microbial activity

Soil organic matter

Infrared spectroscopy
absorption of infrared light by organic matter in soil

- Spectrophotometry colorimetric assays
- color intensity produced by organic molecules in soil sample when reacted to specific reagent
- CIE Lab System - L* lightness, a* red/green coordinate, b* yellow/blue coordinate

% of CARBON = $3.951 \times (1/B \cdot S)$
Where, g = weight of sample in grams
B = Molar salt solution for blank
S = Molar salt solution for Sample

Walkley & Black Method (Dutta et al, 2023)

Loss-on-ignition (LOI)

$\text{mass of soil before ignition (g)} - \text{mass of soil after ignition (g)}$
differences of the mass equivalent to organic matter content in soil

post-analysis

Post-analysis of soil quality testing is a process of reviewing, interpreting, and evaluating results based on the obtained data. This typically involves various of tests.

Data Processing & Interpretation

Comparison with Standard

The processed data is compared with the standard to Contaminated Land Management & Control Guideline No. 1: Malaysian Recommended Site Screening Levels for Contaminated Land (Che Lat, 2023)

Follow-up Monitoring

Recommendation

- Blum, W. E. H. (2005). Functions of Soil for Society and the Environment. Reviews in Environmental Science and Bio/Technology, 4(3), 75-79. <https://doi.org/10.1007/s11157-005-2236-x>
- Culman, S. W., Mann, M., Sharma, S., Saeed, M. T., Fulford, A. M., Lindsey, L. E., Joern, B. (2019). Calibration of Mehlich-3 with Bray P1 and Ammonium Acetate in the Tri-State Region of Ohio, Indiana and Michigan. Communications in Soil Science and Plant Analysis, 1-12. doi:10.1080/00103624.2019.1695825
- Diana Che Lat, Asmani, D., Mohd Hanafie Yasin, Nur, S., Noor, & Razif Razali. (2023). Effect of Soil Contamination on Human Health and Environment with Preventive Measures: A Review. CONSTRUCTION, 3(1), 142-151. <https://doi.org/10.15282/construction.v3i1.9404>
- Indoria, A. K., Sharma, K. L., & Reddy, K. S. (2020). Hydraulic properties of soil under warming climate. Climate Change and Soil Interactions, 473-508. doi:10.1016/B978-0-12-818032-7.00018-7
- Pansu, M. (2006). Handbook of soil analysis. Springer.
- Peveerill, K. I., Sparrow, L. A., & Reuter, D. J. (1999). Soil analysis : an interpretation manual. Csiro Publishing.

In conclusion, soil quality analysis is a multidimensional process that plays a pivotal role in understanding and managing the dynamic nature of soil ecosystems. Through a comprehensive examination of physical, chemical, and biological properties, soil quality analysis provides invaluable insights into the health and fertility of the soils, influencing decisions in agriculture, land use planning, and environmental conservation.

In essence, soil quality testing stands as a cornerstone for responsible land management, fostering a delicate balance between human activities and preservation of vital planetary resources. Through continued research, implementation of best practices, and the dissemination of knowledge, humanity embarks on a journey towards a harmonious coexistence with the land. This journey recognizes that soil health is intricately linked to the well-being of the global environment.

references

- Rai, R. K., Singh, V. P., & Upadhyay, A. (2017). Soil Analysis. Planning and Evaluation of Irrigation Projects, 505-523. doi:10.1016/B978-0-12-811748-4.00017-0
- Qian, J., Xu, W., Mu, L., & Wu, A. (2020). Calibration of Soil Parameters Based on an Intelligent Algorithm Using an Efficient sampling method. Underground Space. doi:10.1016/j.undsp.2020.04.002
- Rajani, A. (2019). Methods of Nitrogen fractions determination from soil.
- United States Department of Agriculture (USDA). (2023). What is Soil? | Natural Resources Conservation Service. Natural Resources Conservation Service. <https://www.nrcs.usda.gov/resources/education-and-teaching-materials/what-is-soil>
- Chen, G., Zhu, H., & Zhang, Y. (2003). Soil microbial activities and carbon and nitrogen fixation. Research in microbiology, 154(6), 393-398. [https://doi.org/10.1016/S0923-2508\(03\)00082-2](https://doi.org/10.1016/S0923-2508(03)00082-2)
- Dutta, P., Ahmed, S., & Samanta, S., & Pramanick, P., Zaman, S. & Mitra, A. (2023). Fish feed from Salicornia- Herbal feed. doi:10.19080/OFOAJ.2023.16.555929