



SOIL FERTILITY

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Ability of the soil to supply nutrients that have relationship nutrients quality, availability & keep from leaching

Foth and Ellis 1997:

Soil fertility is a soil condition that capable to provide essential nutrients for plant without toxic effect from nutrients

SOIL FERTILITY DEFINED

- **Brady:** soil capability to provide nutrients essential that have enough amount and proportional for plant growth
- **Anonymous:** ...part of science that learn about essential nutrients sources and availability for plant quality and production

Abbott & Murphy, 2003. *SOIL BIOLOGICAL FERTILITY. "A key to Sustainable Land Use in Agriculture"*.

SOIL FERTILITY :

The capacity of soil to provide PHYSICAL, CHEMICAL and BIOLOGICAL REQUIREMENTS for growth of plants for productivity, reproduction and quality relevant to plant type, soil type, land use and climatic conditions.

SOIL BIOLOGICAL FERTILITY :

The capacity of ORGANISMS LIVING IN SOIL (microorganisms, fauna and roots) to contribute to the NUTRITIONAL REQUIREMENTS of plants and foraging animals for productivity, reproduction and quality while maintaining biological processes that contribute positively to the physical and chemical of soil.

SOIL CHEMICAL FERTILITY :

The capacity of soil to provide a SUITABLE CHEMICAL AND NUTRITIONAL ENVIRONMENT for plants and foraging animals for productivity, reproduction and quality in a way that SUPPORTS BENEFICIAL SOIL PHYSICAL AND BIOLOGICAL PROCESSES, including those involved in nutrient cycling.

SOIL PHYSICAL FERTILITY :

The capacity of soil to provide PHYSICAL CONDITIONS that support plant productivity, reproduction and quality WITHOUT LEADING TO LOSS of soil structure or erosion and SUPPORTING SOIL BIOLOGICAL AND CHEMICAL PROCESSES.

FERTILITY SOIL

Fertility soil : have chemistry, physics and biology that support to growth/production plant

Fertility

- **Potential :** long term fertility ; difficult to change and to change required high input
- **Actual :** short term fertility ; change every season

Nutrients supply

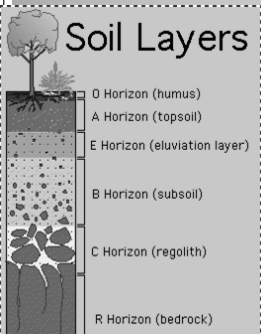
- **Capacity:** supplying nutrients while growing
- **Intensity:** supplying nutrients that continue according growing phase

Problems:

- Nutrients mining → take in yield
- Nutrients unbalance in soils → disproportional fertilizing and used high content fertilizer
- Open nutrients cycle → damage forestry → moving farm and land clearing effect → nutrients decreasing, erosion / run off → nutrients transported
- Sticking out element/ toxic elements → Al, sulphur and heavy metal accumulation from waste
- Salt accumulation
- Sandy soils
- Poor drainage (swamp)

SOIL

Soil Layers



ROLE OF THE SOIL IN PLANT GROWTH



1. **ANCHORAGE**/tempat berjangkar takar tanaman,
2. **STORAGE**/Supply of Water,
3. **STORAGE**/Supply of O₂,
4. **Storage**/Supply of Nutrients.

• Soil fertility components

- Components of soils quality:
 - Root depth ("jeluk mempan perakaran"), solum (soil depth), erosion, conservation, root area (rhizosphere)
 - Soils structure: air-water balance, easy to penetrate the root
 - Soils reaction: nutrients soluble, microbial dominants
 - Nutrient sufficient and balanced: type, amount & ratio
 - Storage of nutrients and moisture: CEC, buffering capacity, moisture retention
 - Humus: Soil organic carbon (C-organic), chelation, energy for microbial
 - Beneficial microbial: synergism, nutrient cycling & material
 - Toxic free material: toxin, waste

Nutrients

(common/nutrients status in soils)

Sources in soils

- Soil organic matter decomposition
- Soil weathering (mineral)
- Fertilizer
- Organic amendment: compost
- N fixation: legum
- Rock: rock phosphate, zeolite
- Industry waste: lime, gypsum
- Air deposition: N, S
- Water deposition: sediment, erosion, flooding

Nutrientscontinue

Nutrient pool

- Soils soluble (provide to be absorb by root)
- Organic matter (decomposition process)
- Soil organism (body component)
- Soil mineral (soluble – low soluble)
- Sorption surface (nutrient absorbed by soil/particel surface use various mechanism)
- Cations exchange (important type from soil surface sorption)

Nutrients that required by plant (functional/essential)

There are 20 essential nutrients

Criteria (Arnon):

1. Deficiencies of nutrient interfere growth
2. Nutrient deficiencies sympton can be eliminated only by these nutrient
3. Theses nutrient must be attached directly in food nutrition

Based on concentration in plant

Macro nutrients (required in large amount)

C, H, O (carbohydrates synthesis), N, P, K (primary nutrients) and Ca, Mg, S (secondary nutrients)

Micro nutrients (required in little amount)

Fe, Mn, Mo, Cu, B, Zn, Cl, Na, Co, Ni, Si

THE ROLE OF PLANT NUTRITION

1. The basic constituent of proteins, polysaccharides, lipids, nucleic acids: N, P
2. ATP production: P, N
3. Photosynthetic pigments: Mg
4. Metabolism of carbohydrates (sugar phosphate): P
5. Moving (translocation) of sugar in the phloem: K
6. Transport of electrons (photosynthesis, mitochondria, structural or enzyme): Fe, S, Cl, Ni
7. Activators of enzymes: K, Mg, Mn
8. Enzyme cofactors: Fe, Zn, Mo
9. Plant growth regulators: Zn
10. Water (osmotic, stomata): K⁺, Na⁺, Ca⁺⁺, NO₃⁻, Cl⁻
11. Reproductive (flower and fruit formation): B
12. For some plants Ni required as an essential nutrient

IMPORTANT

Nutrient deficiensie (essential) will cause sympton in plant, like disease (physiology disease)

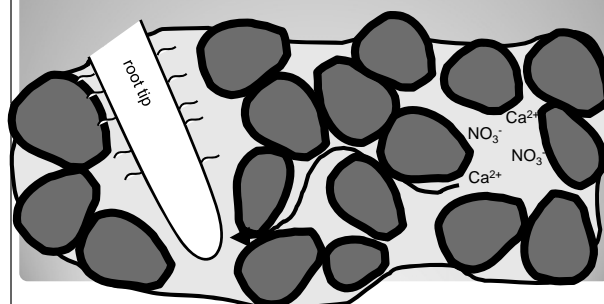
Nutrient can be use for soil fertility indicator

• SOIL-PLANT INTERACTION

• Nutrition move in the soil

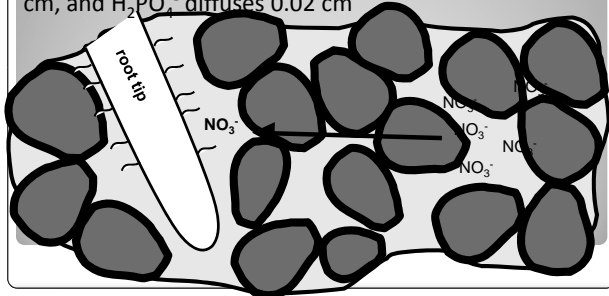
- Ion in the soil will move to root surface by mechanism: root interception, mass flow or diffusion
- Root interception related to nutrition supply (*solely a supply mechanism*)
- Mass flow and diffusion are nutrient supply and transport (*mechanisms of supply and transport*)

MASS FLOW – dissolved nutrients move to the root in soil water that is flowing towards the roots



DIFFUSION – nutrients move from higher concentration in the bulk soil solution to lower concentration at the root;

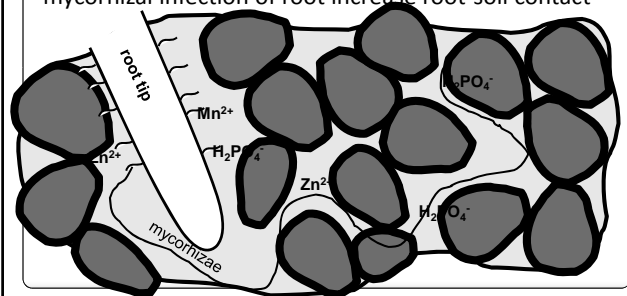
-In the time it takes NO_3^- to diffuse 1 cm, K^+ diffuses 0.2 cm, and H_2PO_4^- diffuses 0.02 cm



ROOT INTERCEPTION – roots obtain nutrients by physically contacting nutrients in soil solution or on soil surfaces;

- roots contact ~1% of soil volume;

- mycorrhizal infection of root increase root-soil contact



Soil Properties

→ usually related with fertility

Soil Chemistry Properties

- pH
- CEC
- Base Saturation
- Nutrient retention
- Free toxic
- Soil organic matter

Soil Properties....continue

Soil Physic Properties

- Soil texture
- Soil Structur
- Aeration
- Drainage
- Soil Consistensy

Soil Properties....continue

Soil Biologi Properties

- Type and amount of soil microbial → actor in nutrient cycling
 - > Decomposer
 - > Rhizobium, mycorhiza
 - > various enzymes
- Organic matter & microbial food



