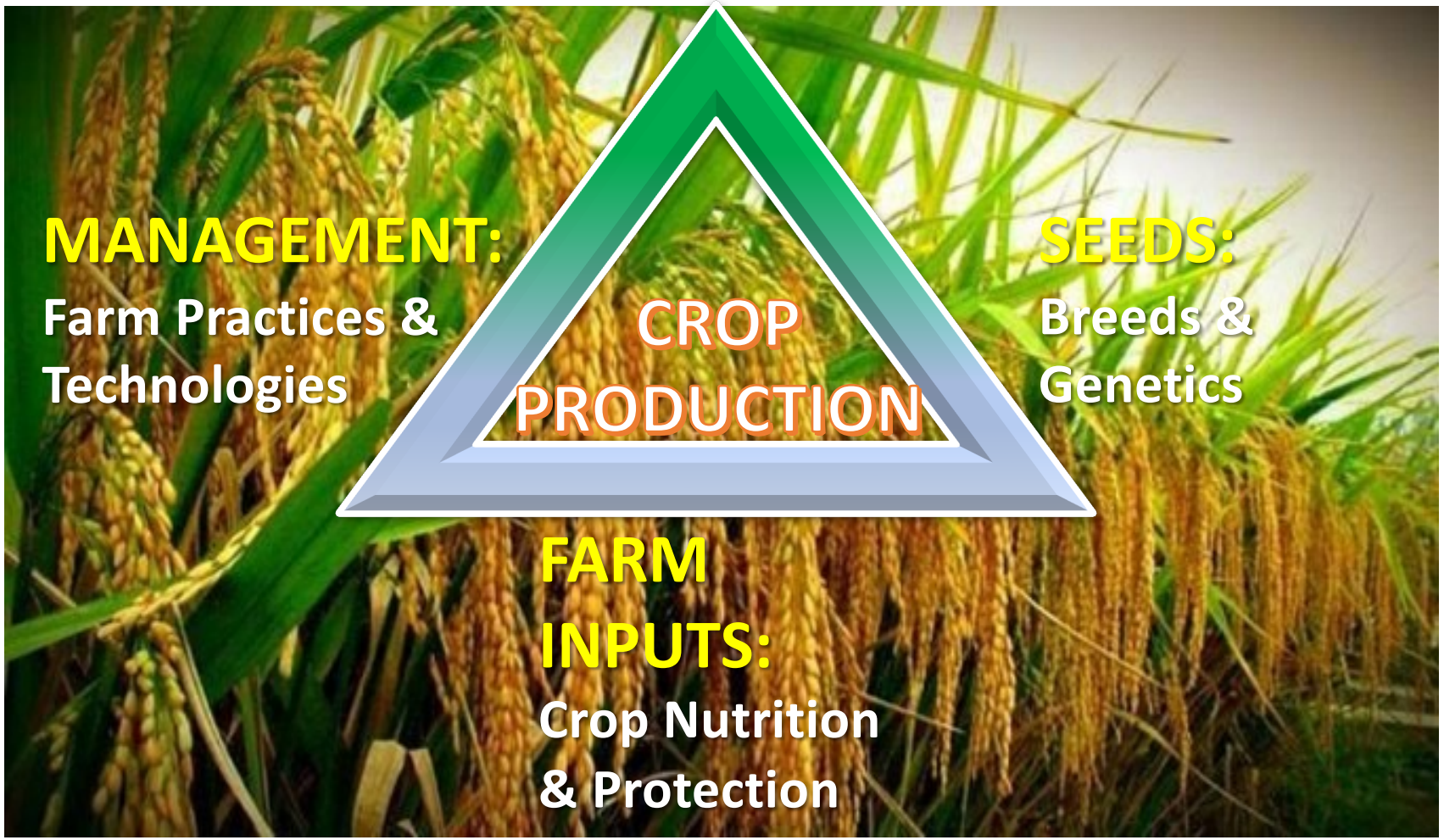
BASIC SOIL NUTRIENT AND SOIL ANALYSIS FOR TURF MANAGEMENT

Patrick M. Rocamora, MAgr
Head and Assistant Professor
Division of Soil Science
ASI, CAFS, UPLB


MANAGEMENT:
Farm Practices &
Technologies
CROP
PRODUCTION
SEEDS:
Breeds &
Genetics
FARM
INPUTS:
Crop Nutrition
& Protection

Essential Nutrient Elements

- There are 18 nutrient elements that are considered essential for plant growth.
- These are:
  - C, H, O, N, P, K, Ca, Mg, S
  - Fe, Mn, Cu, Zn, B, Mo, Cl, Co, Ni

Macronutrients

- The elements that are needed by plants in relatively large amounts than other nutrients.
- **Macronutrients/major elements:**
  - C, H, O, N, P, K, Ca, Mg, S

Micronutrients

- Elements needed by plants only in very small amounts.
- **Micronutrients/trace elements/minor elements:**
  - **Fe, Mn, Cu, Zn, B, Mo, Cl, Co, Ni**

Other Nutrient Elements

- Some plants apparently either need/can benefit from other elements such as:
  - silicon, sodium, iodine, fluorine, barium, and strontium.
    - not considered to be generally essential elements for plant growth.

Essential Nutrient Elements

- These elements exist in soil:
  - in combination with organic compounds
  - in the complex structure of minerals
  - in salts in the soil solution
- When the organic and inorganic compounds decompose and the solutes dissociate into their component ions,
  - the nutrients then become available for absorption by plants/are adsorbed on colloid surfaces.

Forms that are Available for Plant Use

- Nitrogen – NH_4^+, NO_3^-
- Phosphorus – $H_2PO_4^-$, HPO_4^{2-}, PO_4
- Potassium – K^+
- Calcium – Ca^{2+}
- Magnesium – Mg^{2+}
- Sulfur – SO_4^{2-}

Forms that are Available for Plant Use

Iron - Fe^{2+}, Fe^{3+}

Manganese - Mn^{2+}

Boron - H_3BO_3, $H_2BO_3^-$

Zinc - Zn^{2+}

Copper - Cu^{2+}

Chlorine - Cl^-

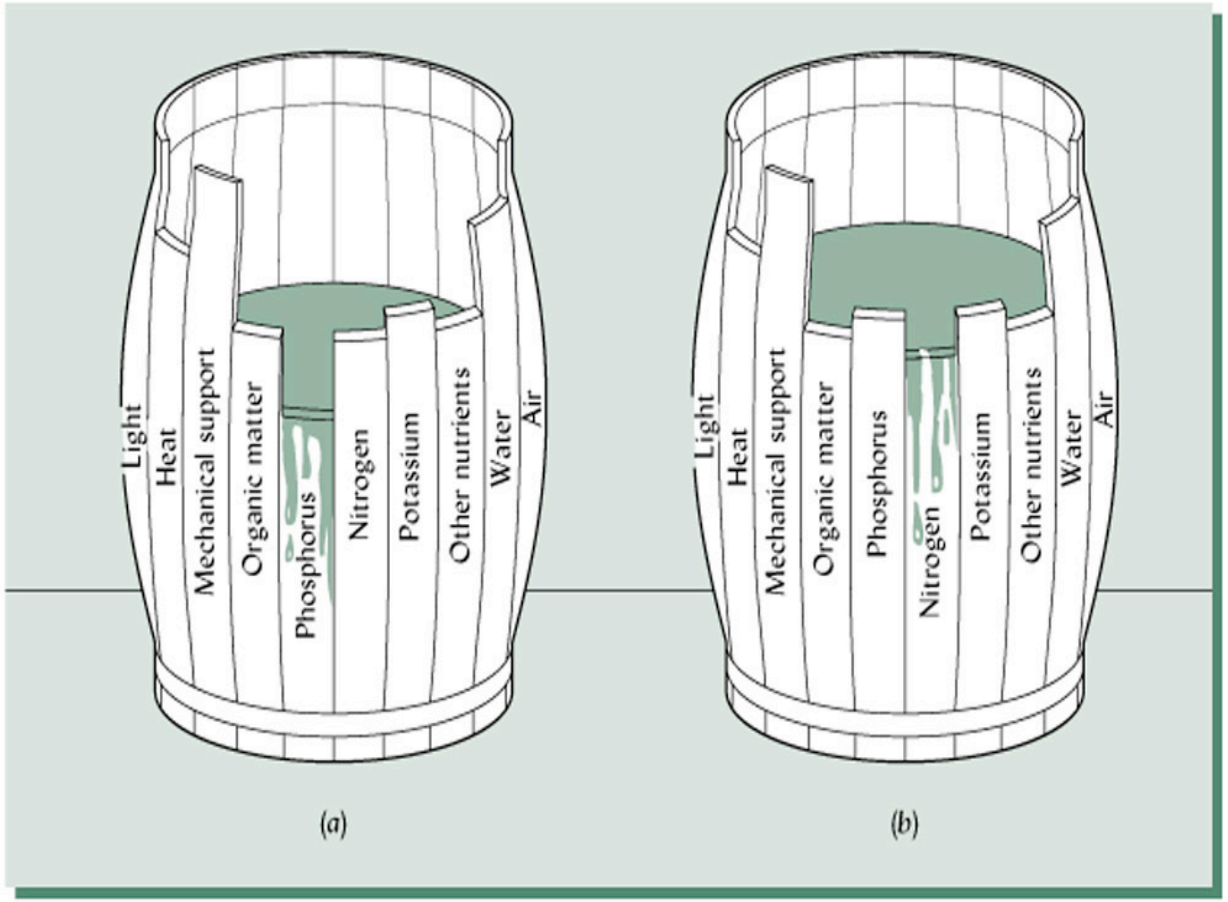
Cobalt - Co^{2+}

Molybdenum - MoO_4^{2-}

Nickel - Ni^{2+}, Ni^{3+}

Justus von Liebig's Law of Minimum

- *"Plant production can be no greater than that level allowed by the growth factor present in the lowest amount relative to the optimum amount for that factor".*



The Concept of Limiting Factor

Plant growth is constrained by the **essential element** (or/other factor) that is **most limiting**.

- the level of water in the barrel represents the level of plant production.

P is represented as being the factor that is most limiting.

- even though the other elements are present in more than adequate amounts, plant growth can be no greater than that allowed by the level of P available.

When P is added, the level of plant production is raised until another factor becomes most limiting

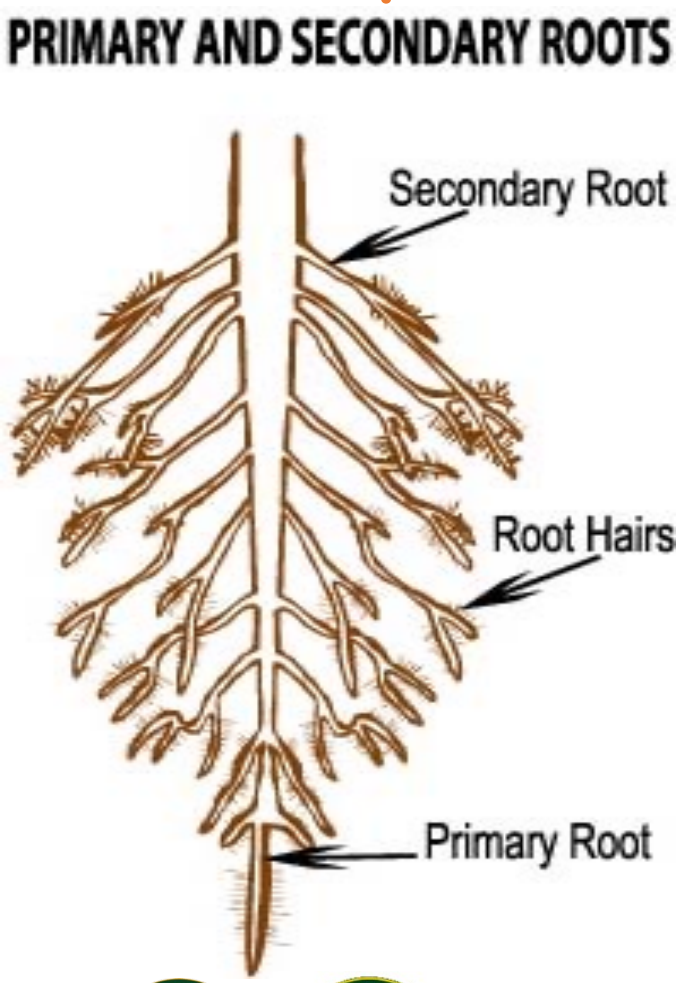
- in this case N.

Essential Nutrient Criteria

1) Plants cannot complete their life cycle in the absence/deficiency of any one of the nutrient elements;
2) The nutrient is an integral component of a plant structure and/or participates in one or more metabolic processes in the plant; and
3) No other element can substitute for the element if it is absent/lacking in supply.
   - its deficiency can only be corrected by addition of that element.

Mechanisms of Nutrient Uptake

- Movement to the roots:
  1) Root interception - exposure to soil and new supplies of nutrients - roots could contact 3% of the soil or nutrients in the soil.

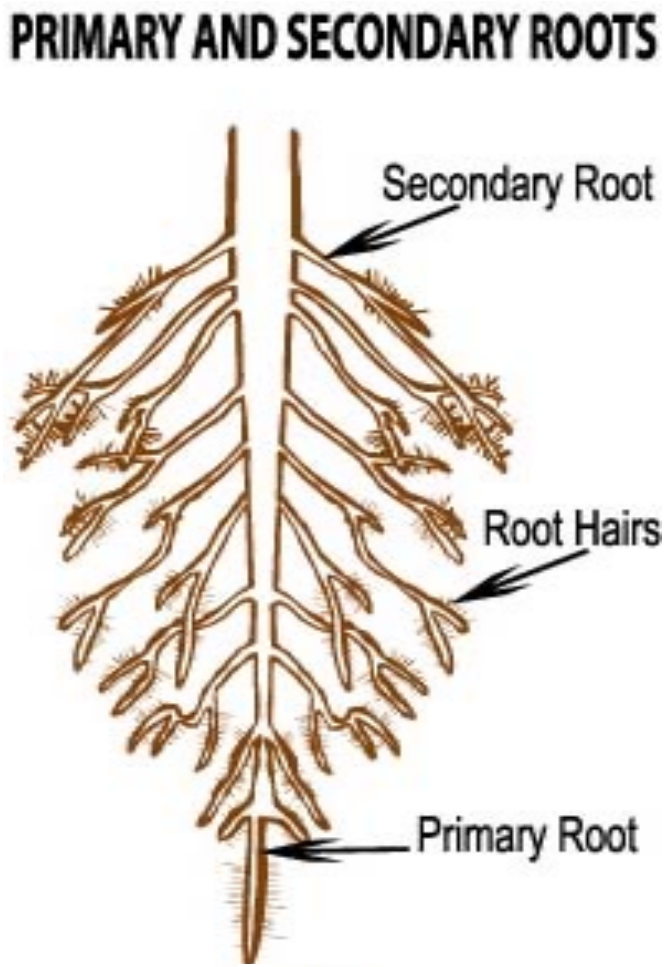


Mechanisms of Nutrient Uptake

- Movement to the roots:

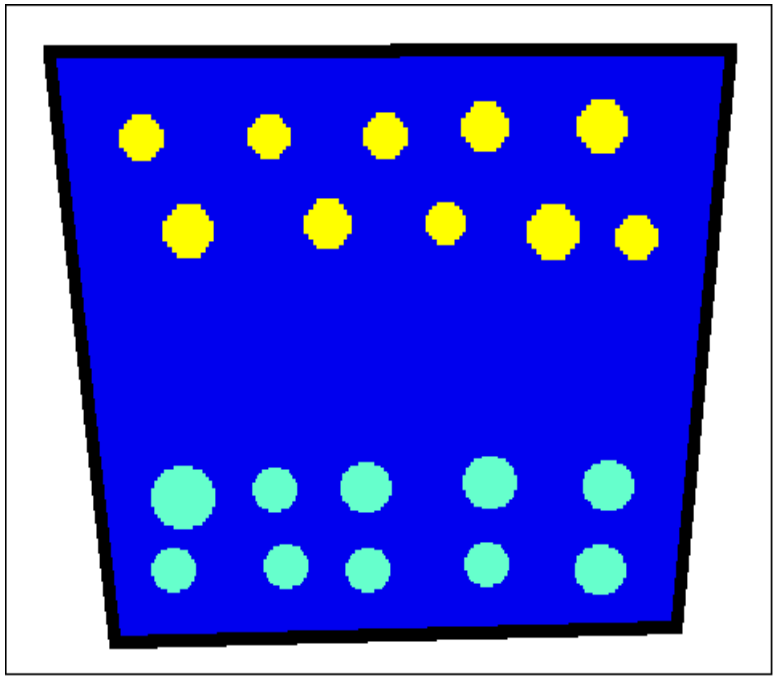
  2) Mass Flow - water absorbed by the root creates a water deficit near the root, more water moves to the root carrying nutrients with the water.

  ➢ important for nutrients in large quantities in the soil solution - N, K, & Ca.



Mechanisms of Nutrient Uptake

3) Diffusion - movement of nutrients due to an imbalance of concentration (diffusion gradient)



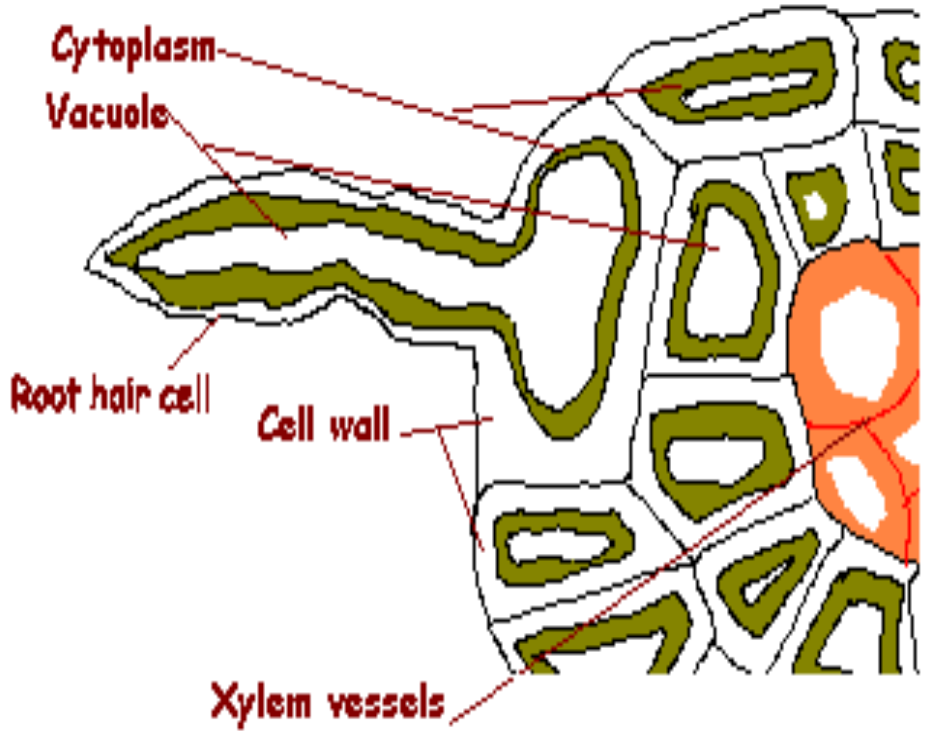
Conditions Required for Nutrient Uptake by Plants

1) Actively growing plants - anything that affects the metabolism of the plant will affect nutrient uptake.

2) Metabolic energy is required.
   - Plant roots must be able to respire.
   - Soils must have oxygen.

Conditions Required for Nutrient Uptake by Plants

3) Root hairs are the most active points of nutrient uptake.



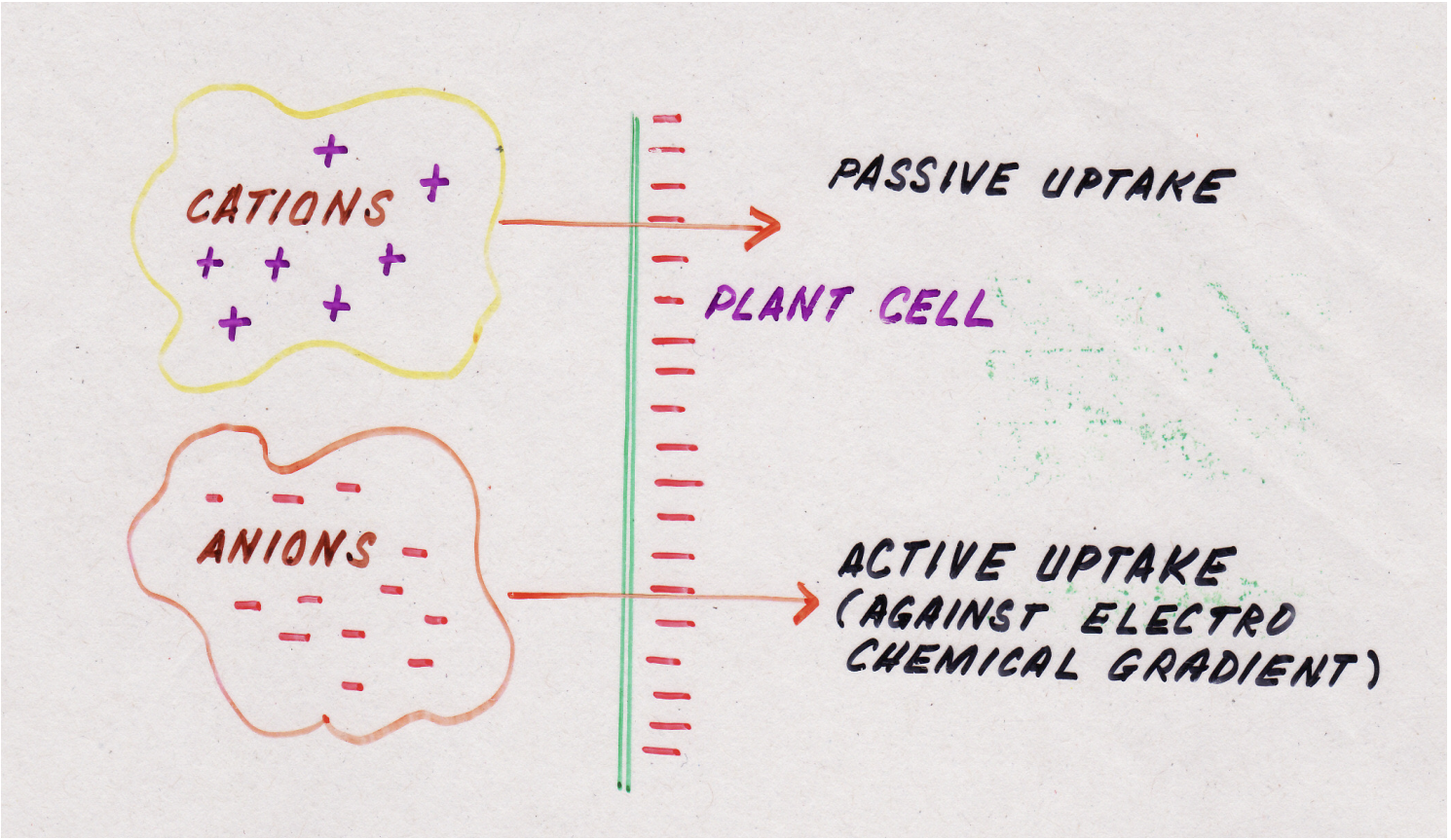
Section of a root

Conditions Required for Nutrient Uptake by Plants

4) Process is selective - a carrier ion moves from plasmalemma across the plasma membrane into the outer space of the walls of the cells of the cortex and picks up a nutrient ion and moves back across the membrane.

Conditions Required for Nutrient Uptake by Plants

Plant cells are negatively charged thus anions must move against an electrochemical gradient.



Functions of Nutrients in Plants

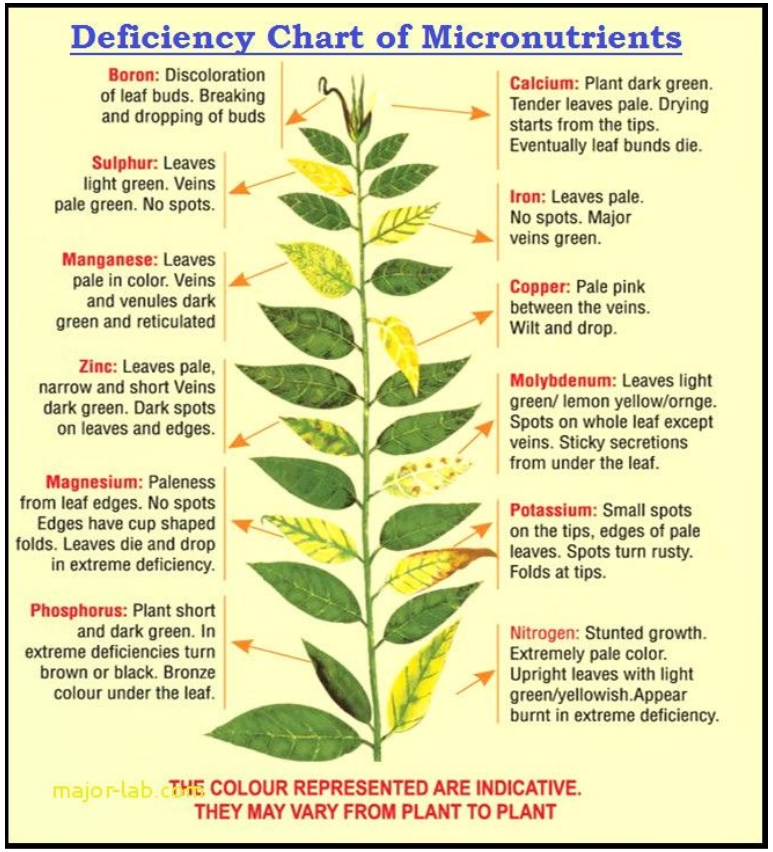
Nitrogen

- Involved in the building up of plant tissues and protein synthesis
  - determines over-all growth.
- A major component of the green pigment chlorophyll.
- N deficiency causes stunting of growth and general yellowing of leaves (chlorosis).

Functions of Nutrients in Plants

Phosphorus

- An important component of phospholipids, nucleic acids, and coenzymes.
- Involved in energy transfer in various metabolic processes as part of adenosine triphosphate (ATP).
- Important in the development of:
  - roots
  - flowering
  - grain formation and development



Functions of Nutrients in Plants

Phosphorus

- Expression of P deficiency:
  - purpling in corn leaves cause by pigment anthocyanin
  - roots are short and branched
  - grains do not fill completely
  - some plants mature too early when P is deficient.

Functions of Nutrients in Plants

Potassium

- K is closely linked to:
  - vigor and resistance of plants to diseases
  - quality of fruits
  - strength of fibers
  - synthesis of oil, sugar, starch, and carbohydrates.

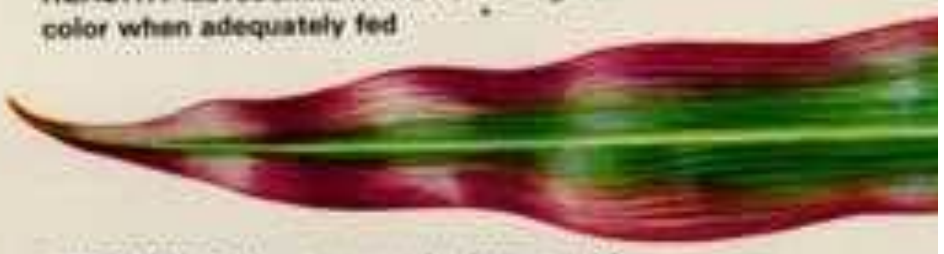
Functions of Nutrients in Plants

- K deficiency is manifested by plants in many ways;
  - foremost of which is the drying up of leaf tips and margins and general loss of vigor.

Plate IV
Figure 31

Guide to Nutrient Deficiency Symptoms

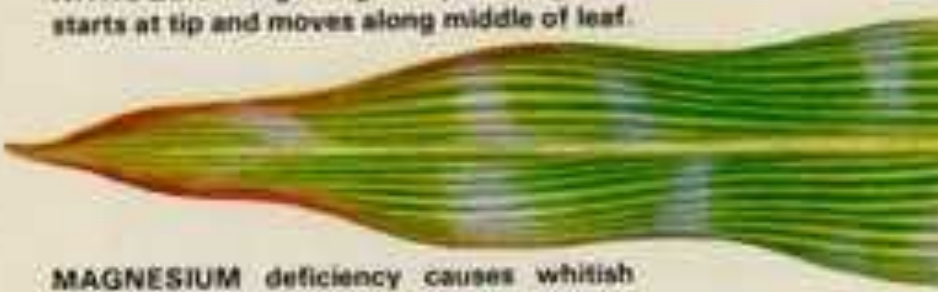
HEALTHY leaves shine with a rich dark green color when adequately fed



PHOSPHATE shortage marks leaves with reddish-purple, particularly on young plants.

POTASH deficiency appears as a firing or drying along the tips and edges of lowest leaves.

NITROGEN hunger sign is yellowing that starts at tip and moves along middle of leaf.



MAGNESIUM deficiency causes whitish strips along the veins and often a purplish color on the underside of the lower leaves.

DROUGHT causes the corn to have a grayish-green color and the leaves roll up nearly to the size of a pencil.

Drawings M

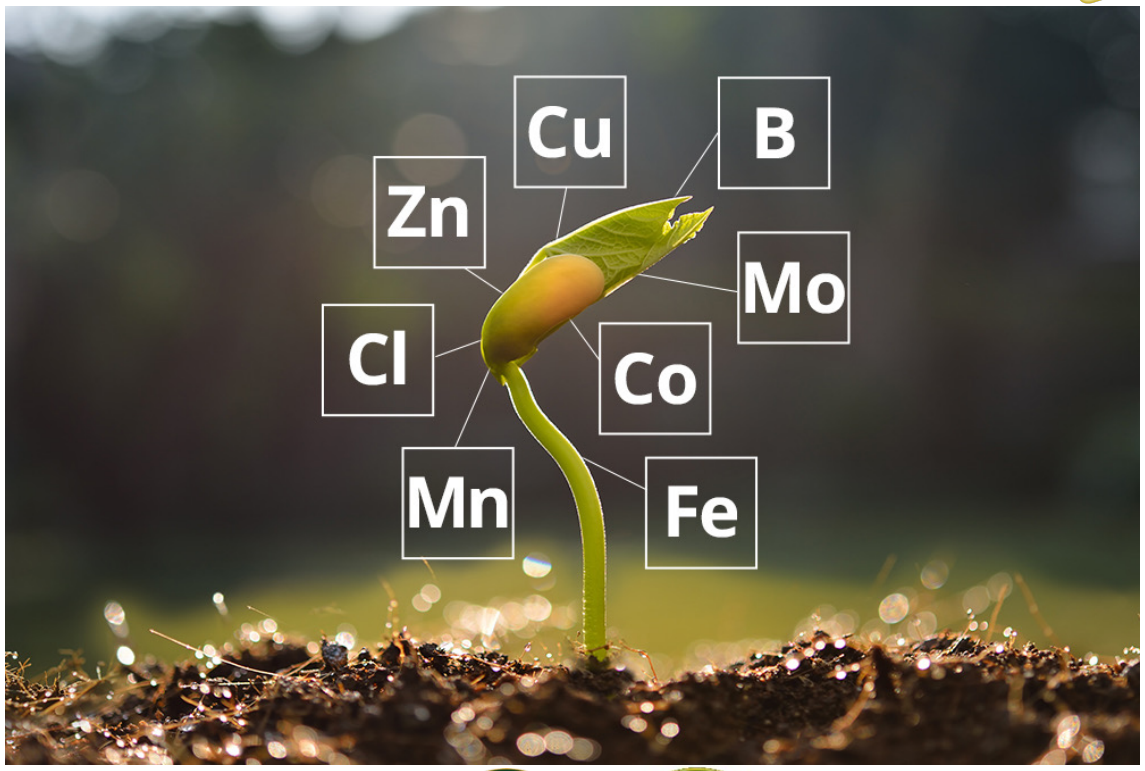
DISEASE, helminthosporium blight, starts in small spots, gradually spreads across leaf.

CHEMICALS may sometimes burn tips, edges of leaves and at other contacts. Tissue dies, leaf becomes whitecap.

Functions of Nutrients in Plants

Micronutrients

- **Involved mostly as:**
  - activator of enzyme reactions
  - respiration
  - various metabolic processes
  - Nutrient mutualism reactions and processes



Functions of Nutrients in Plants

Iron

- Present in several peroxidase, catalase and cytochrome oxidase enzymes
- Found in ferredoxin
  - participates in oxidation-reduction reactions
  - e.g. NO_3^- and SO_4^{2-} reduction and N fixation
- Important in chlorophyll formation

Functions of Nutrients in Plants

Copper

- Present in laccase and several other oxidase enzymes;
- Important in:
  - photosynthesis
  - protein and carbohydrate metabolism
  - N fixation

Functions of Nutrients in Plants

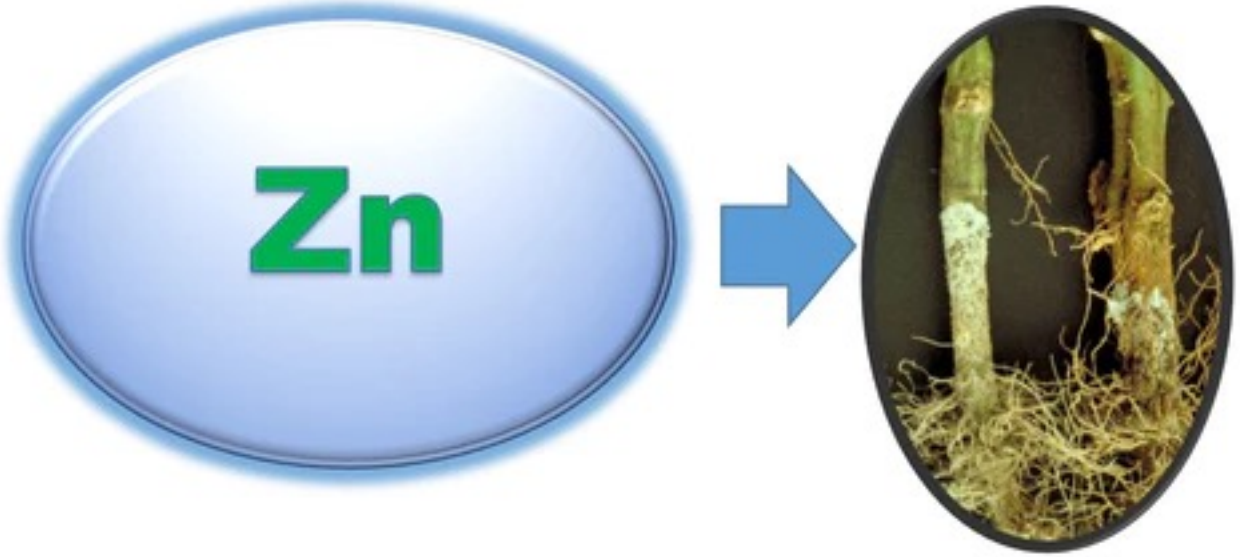
Boron

- Activates certain dehydrogenase enzymes
- Facilitates sugar translocation and synthesis of nucleic acids and plant hormones
- Essential for cell division and development

Functions of Nutrients in Plants

Zinc

- Present in several dehydrogenase, proteinase, and peptidase enzymes
- Promotes growth hormones and starch formation
- Promotes seed maturation and production



SOLID FERTILIZERS vs. FOLIAR FERTILIZER

SOLID FERTILIZERS

- Mas **MABAGAL ANG PAGPASOK NG SUSTANSYA** sa halaman kaya mas mabagal din ang epekto
- **HINDI PANTAY ANG DISTRIBUSYON** ng sustansya dala ng paraan ng pagsabog
- Naglalaman ng mga kemikal na **NAKAKAPINSALA SA LUPA** kaya habang tumatagal, pataas ng pataas ang kinakailangang abono para mapantayan ang dating ani

XANADU MAXPOWER

- **DIREKTA ANG PAGPASOK NG SUSTANSYA** sa pamamagitan ng stomata ng mga dahon
- Mas pantay ang saklaw ng pag-spray, lahat ng pananim ay makakatanggap ng **PAREHONG ANTAS NG SUSTANSYA**
- **MAKAKAPAGPAHINGA AT MAKAKABAWI ANG ATING LUPA.** Naghahatid din ng sustansya ang FOLIAR sa mga mikroorganismo sa lupa

Complimentary Technologies for Nutrient Management

A. Soil and Plant Tissue Analysis
B. Leaf Color Chart (LCC)
C. Soil Test Kit (STK)
D. Minus One Element Technique (MOET)
E. Nutrient Manager

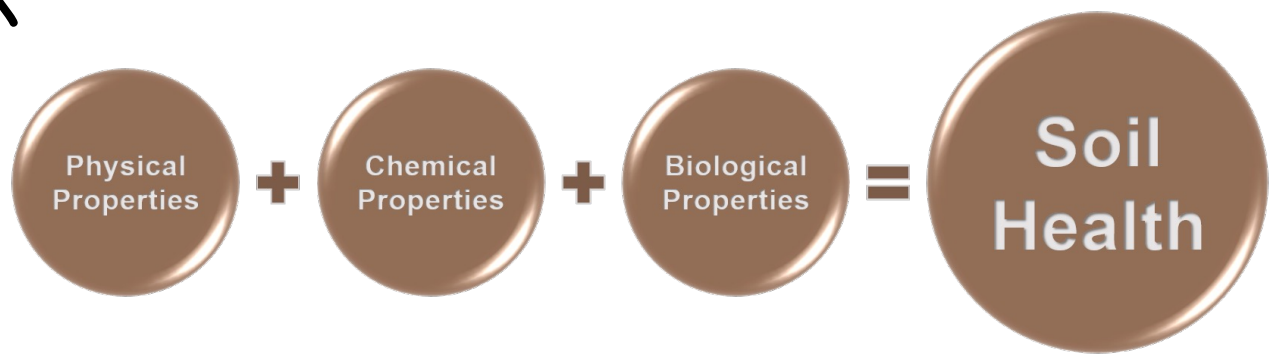
A. Soil and Plant Tissue Analysis

- One of the most reliable tools in determining nutrient deficiencies in plants and determining the soil fertility status
- A laboratory determination of the total or available nutrients in the soil or taken up by plants in a certain period of time

A. Soil and Plant Tissue Analysis

Most soil testing laboratories conduct analyses on:

- Physical (texture, bulk density, moisture and others)
- Chemical (N, P, K and Micronutrients)
- Biological (OM, Microbial populations)



Some examples of laboratory equipment for analysis:

Flame Photometer (K)

Kjeldahl Apparatus (N)

Spectrophotometer (P)

Atomic Absorption Spectrophometer

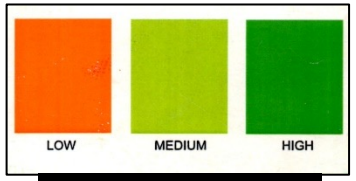
A. Soil Test Kit (STK)

- Portable tool which can provide a quicker method of determining the nutritional status of the soil
- Uses colorimetric method and color change indicators
- Can easily be done in the field

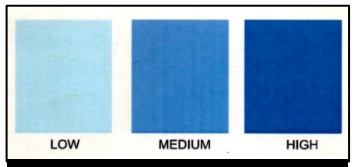
- Highly useful for farmers who need immediate results for the fertility status of the soil

B. Soil Test Kit (STK)

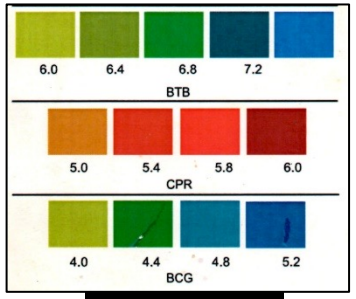
- Uses various solutions which will be added to the soil sample
- Gives a colorimetric reaction after a period of time
- The color of the solution in the sample will be compared to the standard color chart to determine the rate of nitrogen, phosphorus and potassium in the soil
- A field guide book included in the kit can aid in the formulation of fertilizer recommendation based on the resulting ratings of N, P and K



Nitrogen (N)



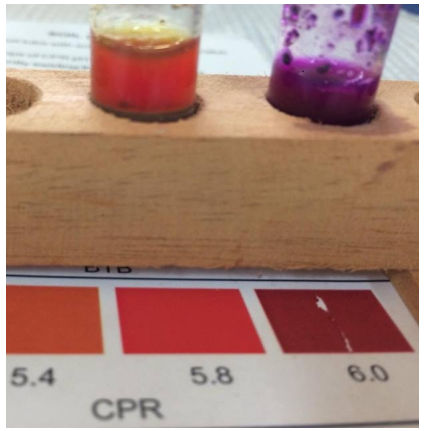
Phosphorus (P)

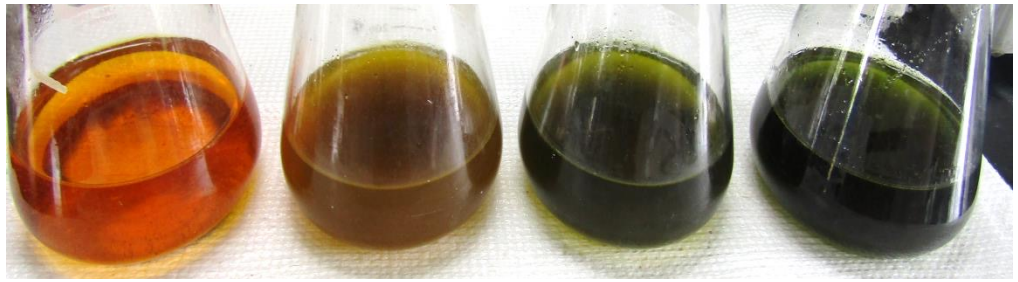


Soil pH

B. Soil Test Kit (STK)

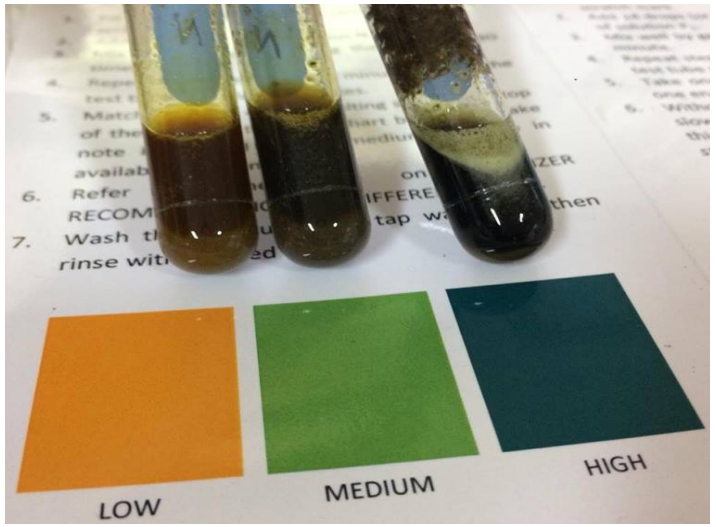
The color chart which rates whether the soil is low, medium, or high in available nitrogen, phosphorus or potassium, and soil pH or acidity.





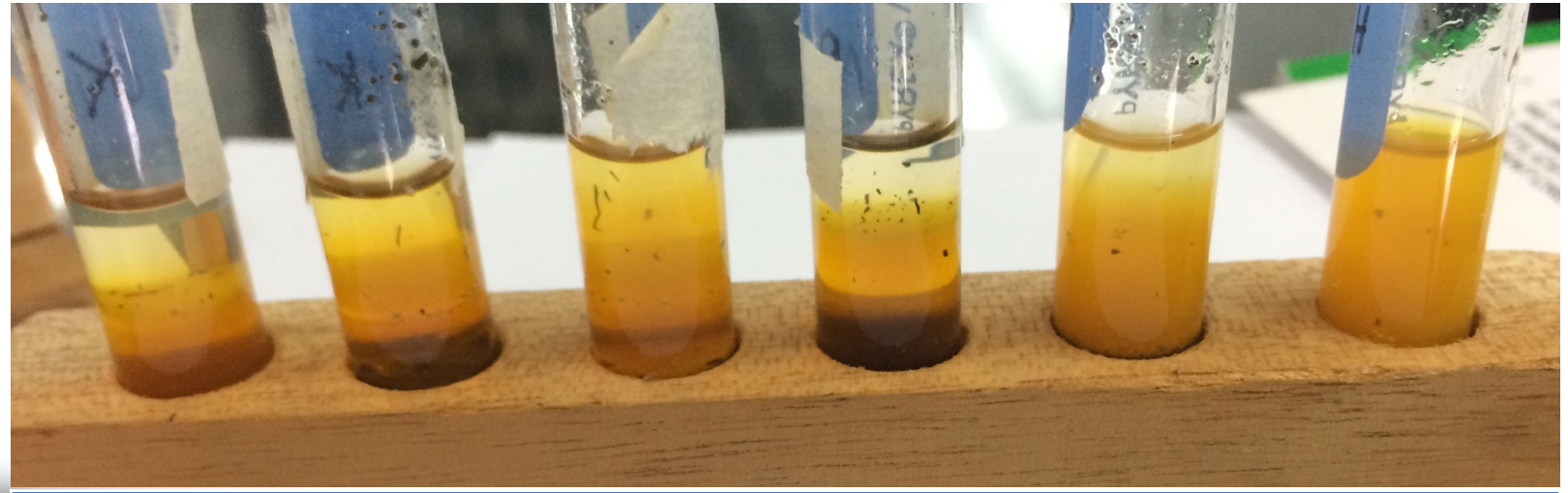
Low	Medium SOM	Medium- High	Very High SOM
0.5% SOM	0.9% SOM	3% SOM	6% SOM

Response of Solution B to different soil types.



B. Soil Test Kit (STK)

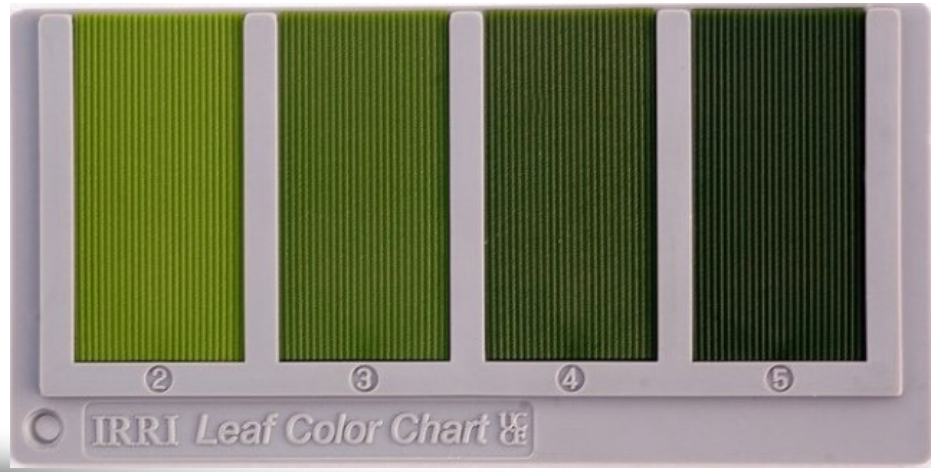
Response of Solution C and C1 in soils with different levels of phosphorus



Response of Solution D, D1 and solution E in soils with different levels of potassium.

C. Leaf Color Chart (LCC)

- A diagnostic tool to determine nitrogen (N) deficiency
- Developed by the International Rice Research Institute (IRRI) and the Philippine Rice Research Institute (PhilRice)



- Qualitatively monitors rice leaves which can indicate the nitrogen status of the plant

C. Leaf Color Chart (LCC)

Using the Leaf Color Chart (LCC)

1. Randomly select at least ten (10) healthy plants from the field starting from 14 days after transplanting (DAT).
2. Match the leaf color of the topmost and youngest leaf against the palette of the LCC without detaching the leaf.
3. Determine the average of the readings.
4. If more than 5 leaves out of the ten (10) sampled plants are below the critical value (3), nitrogen fertilization is required.

- Apply 30 kg N/ha during the dry season (DS) or 23 kg N/ha during the wet season (WS).

International Rice Research Institute. *Leaf Color Chart*. Retrieved 25 June 2019 from http://www.knowledgebank.irri.org/step-by-step-production/growth/soil-fertility/leaf-color-chart
Philippine Rice Research Institute. 2010. *Using the leaf color chart.* Retrieved 25 June 2019 from https://www.pinoyrice.com/wp-content/uploads/using-the-leaf-color-chart-or-lcc.pdf

C. Leaf Color Chart (LCC)

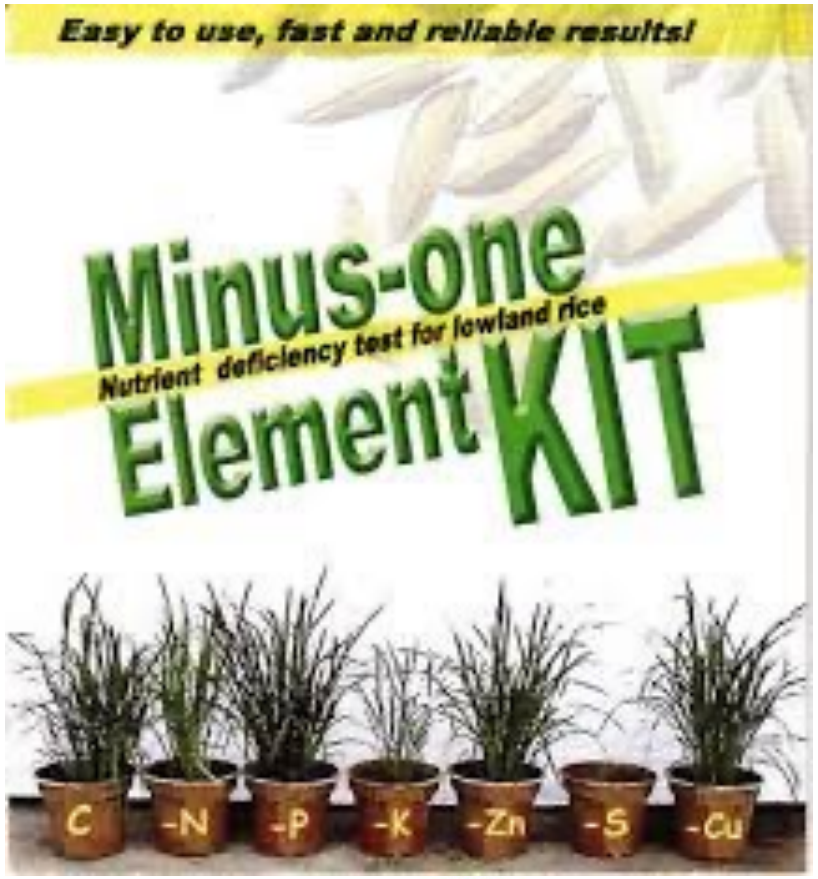
- Variation in the readings using the Leaf Color Chart depends upon the homogeneity of the field

- Heterogenous fields require more sampling areas

PhilRice (1997). Leaf Color Chart. *Rice Technology Bulletin No. 24.* Retrieved on 25 June 2019 from https://www.pinoyrice.com/wp-content/uploads/leaf-color-chart-english.pdf

D. Minus One Element Technique(MOET)

- A method that detects nutrient deficiencies under actual field conditions by using fertilizer formulations that has a missing element
- Based on Liebig's Law of Minimum which states that plant growth is directly proportional to the concentration of the limiting nutrient
- Beneficial for farmers who do not have easy access to a regional field laboratory



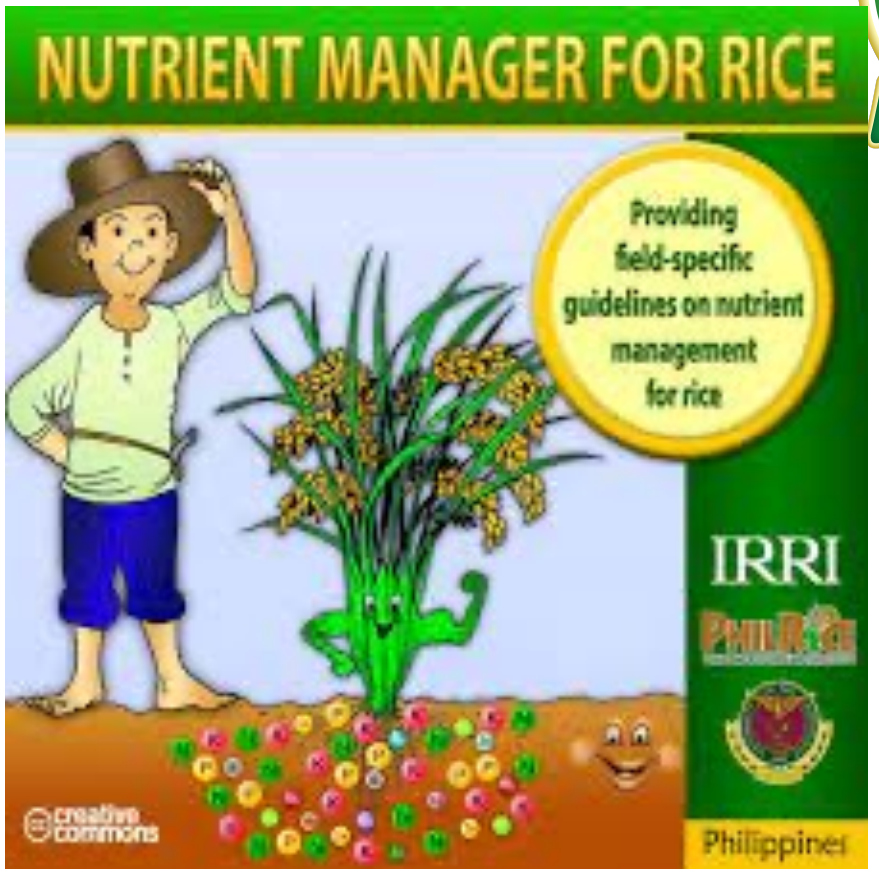
D. Minus One Element Technique(MOET)

- Includes seven (7) fertilizer formulations:
  - Complete
  - Minus Nitrogen (-N)
  - Minus Phosphorus (-P)
  - Minus Potassium (-K)
  - Minus Sulfur (-S)
  - Minus Copper (-Cu)
  - Minus Zinc (-Zn)
- The growth of the plants in each pot will be compared to the pot receiving the Complete treatment
- Requires the use of seven planting pots: one for each fertilizer formulation
- Healthy, normal plant growth in the pots under a specific minus element container indicates that the soil has adequate levels of that nutrient

E. Nutrient Manager

- A web decision-making tool developed by the International Rice Research Institute and the Africa Rice Center

- A tool based on the concept of SSNM (Site-Specific Nutrient Management)



THANK YOU!

Have a fruitful and resourceful seminar.

Questions and Clarifications