Lab. 15: Mineral Nutrition

The nutrition of any living organism includes all these substances that must be supplied to it from outside. These organisms which require both organic and inorganic substances from outside are called Heterotrophic; like animals and non green plants such as Fungi and most Bacteria; and those that need supply the inorganic substances are called Autotrophic such as green plants: they can synthesize their entire biochemical requirement, provided they are supplied with all the essential inorganic elements and grown under normal environmental conditions.

The nutrition of green plants is therefore slowly inorganic. It is correctly mineral nutrition. Elements (**except carbon, hydrogen and oxygen**) are absorbed by the roots are essential elements since they are obtained directly or indirectly from the minerals present in the soil.

The plants are containing a large proportion of water and a relatively small amount of dry substances by drying plant tissues at a temperature (103-105°C) most of water molecules evaporated and the remains called Dry matter or Dry substances in the plant tissue.

Now we are able to distinguish between the organic material and inorganic substances (ash) by burning the dry substances in the (furnace) at a temperature (550-600°C) and we can notice that the organic matter which represent (80-90%) from the dry matter exchange to their original elements and decayed as a gas of (N, O, H and C) elements. The remains are called Plant ash.

Ash represent a mixture of mineral elements (salty or ionized form) which absorbed by the plant. Generally, the ash composed from more than (40) mineral elements.

Ash represent (1-10%) from dry weight of the plant tissue and these proportions differ according to:

1. Age of the plant.
2. Kind of the plant.
3. Kind of the plant tissue.

For example:

leaves	5- 10% ash
Seeds	4 - 5% ash
Fruits	1% ash

Mineral elements division:

The mineral elements in the plants can be dividing according to:

First: essentiality: they divided to:

1. essential elements
2. non essential elements

In order to as certain that any element is essential, it is must be have this conditions:

A. Universal for all plants.
B. Absence leads to deficiency.
C. Absence prevents completion of life cycle.
D. It can not be replaced by any other element.

Second: Plant necessity: they divided to:

1. Macro elements: the plant needs them in a large amount (> 100 ppm).
   Mg, Ca, K, S, P, N, O, H and C
2. Micro elements: the plant needs them in a small amount (1-100 ppm).
   Fe, Zn, Cu, Co, Mo, Mn.
3. Trace elements: the plant needs them in a trace amount (very small).
   Rd, Hg, Se, Cd

Third: Physiological activity or biochemical function

The elements classified as groups, each group have certain roles at the growth and activity of the plant, their pathways to inside the plant body.

Nutrient culture:

1. Soil
   The soil regards as a source of most mineral elements for the plants and because of difference in their characteristics it consider very hard for studying the mineral elements in the soil culture, so that other artificial cultures designed to study a certain element in the plant, like
2. Sand culture
   Solid medium or sand culture (silica or white quartz) which exude from their nutrient elements by washing with diluted (HCl) acid and distal water, then one of nutrient solution's added to it without particular element that we want study its effects.
3. Solution culture or Hydroponic culture
   Aqueous nutrient solutions in which, they immersed the plant roots. They differ in their chemical compositions from these artificial solutions: Hogland, Sach's, Knop, Evan, Long Ashton's solutions.

- **Mineral element's study methods or analysis methods**

The dried powder plant material sample is subjected to:

1. Dry ashing (ash analysis)
   The dried powder exposed to a high temperature in the Furnace, leaving a white powder called ash. Ash is dissolved in warm dilute hydrochloric acid (HCl) or nitric acid (HNO3). Detection of the elements present in the solution obtained by chemical – physical method using atomic absorption spectrophotometer or another methods.
   Disadvantage: all the volatile organic compounds are burnt in to gases.
2. Wet ashing or digestion (chemical analysis)
   A small equal quantity of (sulfuric acid + H2O2) added to the powdered sample and heated on a low flame. The materials dissolve and a clear

solution is obtained, then each element determined with a special way by spectrophotometer or flame photometer.

Practice part: `

Determination of dry weight, water content and ash contents of plant tissues.

Plant tissues
Leaves, roots, stems, seeds, fruits
(10gm fresh weight)

↓ 1 hour - oven – 103 ^{0}C

Dry weight?

↓ 2 hours - furnace (600 ^{0}C).

Ash weight?
For each plant tissue

Ash %?

Moisture%?

$$\text{Moisture \%} = \frac{\text{Wt.of water in plant tissue}}{\text{Wt.of fresh plant tissue}} * 100$$

Wt. of water % = wt. of fresh plant tissues – wt. of dry plant tissues.

$$\text{Organic matter \%} = \frac{\text{Wt. of organic matter}}{\text{Wt. of dry tissues}} * 100$$

Wt. of organic matter = wt. dry plant tissues – wt. of ash

$$\text{Ash \%} = \frac{\text{Wt. of ash}}{\text{Wt. of dry tissues}} * 100$$