

ESSENTIALITY CRITERIA FOR NUTRIENTS

Plants require only light, water, and about 18 elements to support all their biochemical needs. These 18 elements are called essential nutrients. For an element to be regarded as essential, three criteria are required:

1. A plant cannot complete its life cycle without the element
2. No other element can perform the function of the element
3. The element is directly involved in plant nutrition

List of eighteen (18) elements essential for plant nutrition, and classify the essential elements as macronutrients or micronutrients.

1. **Macronutrients:** used in large quantities by the plant
 - a. **Structural nutrients:** C, H, O
 - b. **Primary nutrients:** N, P, K
 - c. **Secondary nutrients:** Ca, Mg, S
2. **Micronutrients:** used in small quantities by the plant
 - . Fe, B, Cu, Cl, Mn, Mo, Zn, Co, Ni

Plants require eighteen elements found in nature to properly grow and develop. Some of these elements are utilized within the physical plant **structure**, namely **carbon (C), hydrogen (H), and oxygen (O)**. These elements, obtained from the air (CO₂) and water (H₂O), are the basis for carbohydrates such as sugars and starch, which provide the strength of cell walls, stems, and leaves, and are also sources of energy for the plant and organisms that consume the plant.

Elements used in large quantities by the plant are termed **macronutrients**, which can be further defined as **primary** or **secondary**. The primary nutrients include **nitrogen (N), phosphorus (P), and potassium (K)**. These elements contribute to plant nutrient content, function of plant enzymes and biochemical processes, and integrity of plant cells. Deficiency of these nutrients contributes to reduced plant growth, health, and yield; thus they are the three most important nutrients supplied by fertilizers. The secondary nutrients include **calcium (Ca), magnesium (Mg), and sulfur (S)**.

The final essential elements are used in small quantities by the plant, but nevertheless are necessary for plant survival. These **micronutrients** include iron (Fe), boron (B), copper (Cu), chlorine (Cl), Manganese (Mn), molybdenum (Mo), zinc (Zn), cobalt (Co), and nickel (Ni).

Table 1: List of the essential elements, their status as macro- or micronutrients, their uptake forms and their plant mobility.

Nutrient	Macro/micro	Uptake form	Mobility in Plant	Mobility in Soil
Carbon	Macro	CO ₂ , H ₂ CO ₃	-	-
Hydrogen	Macro	H ⁺ , OH ⁻ , H ₂ O	-	-
Oxygen	Macro	O ₂	-	-
Nitrogen	Macro	NO ₃ ⁻ , NH ₄ ⁺	Mobile	Mobile as NO ₃ ⁻ , immobile as NH ₄ ⁺
Phosphorus	Macro	HPO ₄ ²⁻ , H ₂ PO ₄ ⁻	Somewhat mobile	Immobile
Potassium	Macro	K ⁺	Very mobile	Somewhat mobile
Calcium	Macro	Ca ²⁺	Immobile	Somewhat mobile
Magnesium	Macro	Mg ²⁺	Somewhat mobile	Immobile
Sulfur	Macro	SO ₄ ⁻	Mobile	Mobile
Boron	Micro	H ₃ BO ₃ , BO ₃ ⁻	Immobile	Very mobile
Copper	Micro	Cu ²⁺	Immobile	Immobile
Iron	Micro	Fe ²⁺ , Fe ³⁺	Immobile	Immobile
Manganese	Micro	Mn ²⁺	Immobile	Mobile
Zinc	Micro	Zn ²⁺	Immobile	Immobile
Molybdenum	Micro	MoO ₄ ⁻	Immobile	Somewhat mobile
Chlorine	Micro	Cl ⁻	Mobile	Mobile
Cobalt	Micro	Co ²⁺	Immobile	Somewhat mobile
Nickel	Micro	Ni ²⁺	Mobile	Somewhat mobile

What are Fertilizers?

Fertilizer is a natural or synthetic substance that is applied to the soil or directly to the plants to improve growth and productivity. They provide essential nutrients to the plants. OR

Fertilizers are chemical substances supplied to the crops to increase their productivity. These are used by the farmers in daily life to increase the crops yield. The fertilizers contain the essential nutrients required by the plants including nitrogen, potassium, and phosphorus. They enhance the water retention capacity of the soil and also increase its fertility.

Classification of fertilizers on the basis of their nature

The different types of fertilizers include:

- Inorganic fertilizer - Nitrogen fertilizer, Phosphorus fertilizer, Potassium fertilizer
- Organic fertilizers - Agricultural waste, livestock manure, municipal sludge

Organic Fertilizers

Organic fertilizers are natural fertilizers obtained from plants and animals. It enriches the soil with carbonic compounds essential for plant growth. Organic fertilizers increase the organic matter content of the soil, promotes the reproduction of microorganisms, and changes the physical and chemical properties of the soil. It is considered to be one of the main nutrients for green food.

Organic fertilizers can be obtained from the following products:

- Agricultural Waste
- Livestock Manure
- Industrial Waste
- Municipal Sludge

Advantages of Fertilizers

The advantages of fertilizers are mentioned below:

- They are easy to transport, store, and apply.
- For supplying a specific nutrient we can select a specific fertilizer due to its nutrient specific nature.
- They are water soluble and can easily dissolve in the soil. So, they are easily absorbed by plants.
- They have a rapid effect on the crops.
- They increase the crop yield and provide enough food to feed the large population.
- They are predictable and reliable.

Disadvantages of Fertilizers

Fertilizers have the following disadvantages:

- They are expensive.
- The ingredients in the fertilizers are toxic to the skin and respiratory system.
- Excessive use of fertilizers damages the plants and reduces soil fertility.
- Leaching occurs and the fertilizers reach the rivers causing eutrophication.
- Long term use reduces the microbial activity and disturbs the pH of the soil.

Fertilizers are used for various purposes.

The uses of fertilizers are mentioned below:

- They are used to provide additional nutrients to the plants.
- They are added to improve the yield of the crops.
- Nitrogen-rich fertilizers are used for the greening of lawns.
- Organic fertilizers improve the texture and fertility of the soil.
- Gardeners use fertilizers to address certain needs of the plants such as nutritional needs.
- Fertilizers are added to plants to replace the lost nutrients.

Importance of Fertilizers

It is very difficult to meet the demands of the increasing population with such less resources.

Loss of soil fertility, pests, and lack of nutrients have resulted in a decrease in agricultural production. This has increased the importance of fertilizers in agriculture.

Fertilizers can be important to the plants in the following ways:

- Fertilizers increase plants' tolerance towards pests. This has reduced their reliance on insecticides and herbicides, thereby, producing healthier crops. Consequently, diseases have reduced providing aesthetic value to the crops.
- Fertilizers improve the water holding capacity of the plants and increase root depth.
- The potassium content present in the fertilizers strengthens the straws and stalks of the plants.
- The phosphorus present in the fertilizers helps in the faster development of roots and formation of seeds in the plants.
- Nitrogen in the fertilizers enhances the growth of the plants which can be characterized by the green color of the plants.

Since the chemical fertilizers adversely affect soil fertility, biofertilizers were brought into use. These are substances that contain living or latent cells, and even micro-organisms. They provide the soil with the necessary nutrients and microbes for the growth of the plants. They help the soil to retain its fertility. They are environment-friendly. They also destroy pathogenic components responsible for causing disease in plants. *Acetobacter* and *Rhizobium* are two such widely used biofertilizers.

What are the main components of fertilizers?

The main components of fertilizers include- nitrogen, phosphorus, and potassium. Its rating describes the amount of nitrogen, phosphorus, and potassium in a fertilizer.

What are the drawbacks of using fertilizers?

The excess nutrients from the fertilizers run off into water bodies and cause algal blooms. These algal blooms sometimes restrict the passage of waterways. When the algae die, they sink to the bottom of the water bodies and reduce the oxygen content in water. Also, excess use of fertilizers reduces the fertility of the soil.

What are the three numbers on fertilizers?

The three numbers on fertilizers represent the primary nutrients. A bag of fertilizers labelled 10-10-10 contains 10% nitrogen, 10% phosphorus and 10% potassium. This label is a national standard and is known as the fertilizer grade.

Key Points

- An element is essential if a plant cannot complete its life cycle without it, if no other element can perform the same function, and if it is directly involved in nutrition.
- An essential nutrient required by the plant in large amounts is called a macronutrient, while one required in very small amounts is termed a micronutrient.
- Missing or inadequate supplies of nutrients adversely affect plant growth, leading to stunted growth, slow growth, chlorosis, or cell death.
- About half the essential nutrients are micronutrients such as boron, chlorine, manganese, iron, zinc, copper, molybdenum, nickel, silicon, and sodium.

Key Terms

- **Micronutrient:** a mineral, vitamin, or other substance that is essential, even in very small quantities, for growth or metabolism

- **Chlorosis:** a yellowing of plant tissue due to loss or absence of chlorophyll
- **Macronutrient:** any of the elements required in large amounts by all living things

Type of fertilizers of the basis of essential nutrients

There are following types of fertilizers

Straight fertilizers

The fertilizer which contains only one/single essential plant nutrient known as straight fertilizers. Like urea, Single Superphosphate (SSP) etc.

Compound fertilizers

The fertilizer which contains two or more essential plant nutrients known as compound fertilizers e.g. Diammonium phosphate (DAP), Nitrophosphate, etc.

Complete fertilizers

A single fertilizer material containing the entire three major plant nutrients viz, N, P and K

Mixed fertilizers

Mixed fertilizer typically refers to a fertilizer that are obtained by thoroughly mixing the ingredients either manually or mechanically. NPK mixture fertilizers are formulated and recommended by agricultural scientists to enhance the output of crops by giving it specific and exclusive blend of plant nutrients e.g. NPK fertilizer etc. Mixed fertilizers have a number of advantages, a few of them being: Use of mixed fertilizers results in reduction of labor costs as applying a mixture consumes lesser time as compared to applying the components separately.

Fertilizer grade

This refers to the minimum guarantee with regard to the nutrient content of the fertilizer mixture in terms of N, P and K.

Fertilizer formula

This related to the quantitative expression of the analysis of the different ingredients included in the mixed fertilizer in terms of N, P and K.

Fertilizer ratio

This indicates the relative percentage of N, P₂O₅ and K₂O in the manure mixture.

Acidic fertilizer

Fertilizer capable of increasing the acidity of the soil by continued applications.

Basic fertilizer

Fertilizers which increase the pH and the soil on continued use by leaving a basic residue in the soil.