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Review Article

Significances of Plant Nutrients in Agriculture

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A B S T R A C T

Nutrients are essential compounds found in food that are crucial for the survival and growth of living organisms. They serve as building blocks for various biological processes, aiding in energy production, cell development, and overall health maintenance. In the context of plants, nutrients play a fundamental role in their growth, development, and ability to fend off diseases and pests. Plants, unlike animals and humans, are capable of producing their own food through photosynthesis. However, they still heavily rely on obtaining essential nutrients from the environment to support their life cycle. Plants require various nutrients to germinate, grow, resist diseases, and reproduce. Plants, through the process of photosynthesis, generate their own food. However, they absorb essential nutrients from the soil through their root systems. These nutrients are then transported to different parts of the plant, primarily to the aerial parts above ground level, where they are utilised for various physiological functions.

Keywords: Photosynthesis, Ecosystem, Macro Nutrients, Micro Nutrients, Nutrient Cycles

Introduction

For healthy growth and development, plants require nourishment, just like animals and humans do. Plant nutrients are made up of a variety of chemical components that serve as food for plants. Numerous other nutrients are also necessary for plant growth, but they must be present in considerably larger amounts. Plants frequently have nutrient deficiencies due to conditions in the soil, such as pH, soil structure, or irrigation, that hinder the soil's ability to absorb nutrients.[1]

Classification of Plant Nutrients

Plant nutrition elements are categorised as follows based on the nutrients that the plants require:

Macro Nutrients: Major or macro nutrients are the components that plants need in significant amounts. C, H, O, N, P, K, Ca, Mg, and S are among them.

Additionally, these are divided into two categories:

- **Primary Nutrients:** The plants need rather high concentrations of N, P, and K. These elements are hence referred to as fundamental or main nutritional elements. Large amounts of N, P, and K fertilisers are utilised by farmers. Thus, N, P, and K are referred to as fertiliser elements.
  Secondary Nutrients: Although they are not as important to plants as the primary nutrients, calcium, magnesium, and sulphur are nonetheless needed in substantial quantities. These substances are therefore referred to as secondary nutrients. The production of NPK fertilisers takes precedence over the significance of Ca, Mg, and S.

Macronutrients

Macronutrients are essential elements required in relatively larger quantities for healthy plant growth and development.

They serve as the building blocks for crucial structural components and are vital for various metabolic processes within plants.

Types of Macronutrients

- **Nitrogen (N):** Essential for chlorophyll production, facilitating photosynthesis, and promoting overall plant growth.
- **Phosphorus (P):** Facilitates energy transfer, stimulates root growth, root development, flowering and maturity.
- **Potassium (K):** Crucial for regulating water uptake, enzyme activation, nutrient movement in plants and enhancing resistance to diseases.
- **Iron (Fe) :** This is very much needed for chlorophyll production and in many biochemical plant processes.
- **Calcium (Ca) :** Essential for root health, new root growth and leaf development.
- **Magnesium (Mg) :** Crucial for chlorophyll synthesis and photosynthesis.
- **Sulfur (S) :** Constituent of amino acids, influences plant flavor compounds.[2,3]

Sources and Application

These macronutrients are typically obtained from the soil or supplemented through fertilisers to ensure an adequate supply for optimal plant growth. The deficiency or imbalance of any of these macronutrients can significantly impact plant health and productivity.

Micronutrients

Micronutrients, also known as trace elements, are essential elements needed in smaller quantities but are equally indispensable for plant growth and development.

Types of Micronutrients

- **Iron (Fe):** Vital for chlorophyll synthesis and electron transport in photosynthesis.
- **Zinc (Zn):** Aids in enzyme activation and contributes to overall plant growth.
- **Manganese (Mn):** Essential for nitrogen metabolism and photosynthesis.
- **Boron (B) :** Necessary for RNA formation, cellular activities, and root growth.
- **Molybdenum (Mo) :** Component of major enzymes, essential for nitrogen assimilation.

Importance and Application

Each of these micronutrients plays a specific role in various metabolic pathways critical for plant functions. Although required in smaller quantities, micronutrients are indispensable for enzyme activities, hormone production, and various physiological processes within plants. Correcting micronutrient deficiencies through appropriate fertilisation practices is crucial to preventing stunted growth or diminished yield.

Carbon, hydrogen, oxygen, nitrogen, sulphur, and phosphorus are the building blocks of all living things, biomolecules, and cells. These substances are necessary for life. For life to exist, recycling and constant nutrient replenishment in the environment are essential. There are several biotic, physical, and chemical variables that affect the pace of nutrient cycling. A few instances of nutrient cycles are the nitrogen, oxygen, water, and carbon cycles.

Nutrient Cycling is Important For

- The conversion of nutrients into other forms that are easily absorbed by various species. For example, plants require the fixation and conversion of atmospheric nitrogen into ammonium and nitrate in order to be able to absorb it.
- Cycles of nutrients maintain the ecosystem's balance.
- Living things interact with the abiotic elements of their environment through the cycling of nutrients.

Organisms would not have access to certain nutrients necessary for their survival in the absence of nutrient cycling. Additionally, it maintains the equilibrium of some nutrients, which are essential for an ecosystem to support life. Ecosystems may become unbalanced in the absence of nutrient cycling. Biotic and abiotic elements are involved in the recycling of nutrients. The three primary abiotic elements are soil, water, and air. While calcium, phosphorus, potassium, and other elements are mostly recycled in soil and are readily available locally, carbon, hydrogen, nitrogen, and oxygen are recycled in water, air, and soil.[4]

The Four Primary Cycles of Nutrients are

Carbon Cycle

The primary component of all living cells is carbon. Approximately 45 percent of the total mass of plant tissues is carbon. Carbon Cycle: Living things are made of carbon. Although it is mostly found in the Earth's crust, carbon is also present in the atmosphere and oceans. Through the process of photosynthesis, carbon dioxide is naturally released into the atmosphere of the planet.[5]

In the presence of sunshine, green plants use photosynthesis to create carbohydrates like glucose, fructose, and starch from CO2 and water. There is carbon in these carbs.

Chemical Equation

$$6CO_2 + 6H_20 \xrightarrow[\text{Sunlight}]{\text{Chlorophyll}} C_6H_{12}O_6 + 6O_2$$

Fats and oils are also synthesized by the polymerization of simple sugars like pentoses and hexoses, of which carbon is an essential constituent.

Nitrogen Cycle

Additionally, nitrogen is a necessary element for life. Living things require the conversion of nitrogen into different forms because they are unable to use it directly. All proteins in plants are synthesised with the help of nitrogen. These are required for the creation of enzymes, which regulate every vital function of a living thing, including growth, respiration, and photosynthesis. Proteins and chlorophyll require nitrogen to function. The rate of photosynthesis is increased by chlorophyll. Additionally, it can be found in a wide range of substances that are crucial to plant metabolism physiologically, such as hormones, enzymes, vitamins, and alkaloids. The plant turns pale green at first, then yellow, which is the first obvious indication. This occurs as a result of the plant's reduction in chlorophyll synthesis, which keeps the leaves appearing green. The plant will have fewer leaves and grow more slowly. There are other possible causes for this, such as a soggy plant. Additionally, it is relatively simple to overfeed a plant with nitrogen. This may lead to an overabundance of lush, green growth, which increases the plant's vulnerability to insect and disease attack. Moreover, it may result in less fruit, tuber, or root output.[6,7]

Oxygen Cycle

Life depends on oxygen. Water-dissolved oxygen is essential to aquatic life. The decomposition of biodegradable waste materials requires oxygen. The processes of respiration, or breathing, and photosynthesis are closely related. In addition to releasing carbon dioxide, which is necessary for plants to carry out photosynthesis, breathing by animals also releases oxygen, which is breathed by humans and other creatures.

The primary source of atmospheric oxygen is photosynthesis.

During respiration, living things absorb oxygen from the atmosphere and exhale carbon dioxide, which plants use for photosynthesis.[8]

Water Cycle

The existence of life on Earth depends on water. Water is a crucial component of life since it makes up 70% of plants and 70% of animals on Earth, and it covers 71% of the planet's surface. Now let's discuss the environmental cycle of water. Evacuating water from plants, rivers, lakes, and seas releases water vapour into the atmosphere. Clouds are created when water condenses and cools in the atmosphere. When the clouds are fully loaded with water, the water is released as precipitation, which includes snow and rain. returning the water to the earth as a result. Subsequently, the water may either freeze or seep into the ground through the soil. The cycle of water keeps evaporating, condensing, and precipitating.

The process of evapouration and transpiration from plant surfaces converts water from lakes, rivers, oceans, and other reservoirs into vapour continually.

The cycle continues when water vapour condenses and returns as precipitation.

Groundwater is created when water that falls on the earth is absorbed and stored.[9,10]

Conclusion

Nutrients play a crucial role in facilitating the growth and development of plants. As plants progress through their life cycle, their nutrient requirements evolve and increase. Plants primarily depend on the availability of these nutrients in the soil for sustenance. Additionally, fertilisers are utilised to supply essential nutrients, ensuring optimal growth and mitigating any deficiencies that might hinder crop production. Following death and decomposition, nutrients taken up by plants and animals are released back into the environment, continuing the cycle. Microbes in the soil are crucial to the recycling of nutrients. They release nutrients by breaking down organic materials. In order for plant roots to absorb nutrients from the earth, they must also be captured and transformed.

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