Lesson 3: Plant Growth Factors

In order to discuss the process by which plants grow, a definition of plant growth is needed. Plant growth is an irreversible process during a plant's life that increases plant volume or dry weight or both. Scientists and agriculturalists are concerned with factors that affect plant growth. Understanding the factors that influence plant growth is beneficial to everyone, including consumers who purchase food at the grocery store.

Factors Affecting Plant Growth

Plant growth is affected by the environment. Factors that affect plant growth are light, water, nutrients, and temperature. Each factor affects specific processes or a combination of processes within the plant that directly relates to plant growth and development.

Light

Light is essential for plant growth. Normal plant growth requires the full range of the visible spectrum of sunlight. Plants react to light through the process of photosynthesis, phototropism, and photoperiodism.

Photosynthesis: Photosynthesis is a chemical process that takes place within plant cells. Photosynthesis changes nonliving materials into food. Through photosynthesis, water (H_2O) and carbon dioxide (CO_2) in the presence of light are converted into energy-rich organic compounds (sugars). Once these sugars (carbohydrates) are formed, they can be changed or transformed into starches. Products from the process of photosynthesis are used by the plant as food for growth and development.

Phototropism: Phototropism is a term for the reaction of plants caused by exposure to light. In the process of plant growth, organic chemical substances within the plant are involved. These chemical substances, which are known as hormones (growth regulators), can either promote or inhibit growth. In phototropism, the hormones stimulate longitudinal growth of the plant's stem.

As the hormones move throughout the plant's phloem system, they affect other growth processes such as seed germination, flower initiation, flower growth, and pollen-tube growth.

Phototropism causes the plant to bend and grow toward light. The reason for this bending action is the accumulation of hormones on the dark side of the plant. The accumulation of hormones causes the cells to become elongated. Cell elongation causes the stem to bend towards the light. Phototropism stimulates plant growth through movement of the plant.

Photoperiodism: One other plant reaction to light is photoperiodism. Photoperiodism is the growth response of plants caused by the number of light and dark hours in the day. Photoperiodism is commonly referred to as "day length." In the process of plant growth, formation of the flower is vital in the production of seed. In many plant species, flower formation depends upon day length. By understanding the plant species' photoperiodism requirements, flowering can be manipulated in controlled environments such as greenhouses. Not all plants need a specific length of daylight hours to produce flowers. However, all plants require light to complete their life cycles and continue to produce more seeds.

Water

Water is considered an essential element in plant growth. Depending on the plant, moisture content can vary from 15% to 95% of the plant's "fresh" weight, or weight of green material. When moisture is removed, the actual Weight of "dry" matter can be calculated. Water provides a means by which minerals can be taken up and transported throughout the plant. Water is involved in many chemical reactions throughout the plant. Although all plants require water, the amount of water required differs with each plant species.

Nutrients

Plants also have nutritional needs in order to grow and develop properly. The greatest percentage of the content of a herbaceous plant (a plant that lacks woody tissue) is water. Plant dry matter consists of three main elements: carbon, hydrogen, and oxygen. These three elements are made available to the plant by water, carbon dioxide, and oxygen. Plants also require 13 other essential elements for

proper growth. These elements can be divided into two groups: macronutrients and micronutrients.

Plants require larger amounts of the macronutrients than micronutrients. The macronutrients include: nitrogen, phosphorous, potassium, calcium, magnesium, and sulfur. Macronutrients can be divided into primary and secondary categories. Primary macronutrients are nitrogen, phosphorous, and potassium. Secondary macronutrients are calcium, magnesium, and sulfur. To better understand the plant's need for the macronutrients, see Table 3.1, which lists the nutrients and their functions.

Micronutrients are those that plants require in small amounts (parts per million, ppm) per unit of plant dry matter. Micronutrients are: boron, manganese, copper, zinc, iron, chlorine, and molybdenum.

Methods to Obtain Nutrients

Plant growth depends on the availability of the essential nutrients. In order for nutrients to be helpful to the plant, the plant must be able to bring them up into its structure. A plant obtains nutrients by the processes of absorption and osmosis. Nutrients are then transported throughout the plant by translocation. During the transpiration process, oxygen is released into the atmosphere through the stomata in the leaves.

Absorption is the process through which plants absorb nutrients and water from the soil through its roots. Absorption is most active just above the root tip in the region of the hair roots. Once water and nutrients have been absorbed into the plant, they are then used for various needs.

Table 3.1 - Macronutrients

Primary Macronutrients	**Use of nutrient in plant**
1. Nitrogen	Needed in making proteins Increases plant green color Promotes rapid growth
2. Phosphorus	Promotes early root formation Promotes vigorous start Hastens maturity
3. Potassium	Increases vigor and disease resistance Increases strength of stalkes Increases gain size
Secondary Macronutrients	**Use of nutrient in plant**
4. Calcium	Promotes early root formation Improves general plant vigor Component of cell walls
5. Magnesium	Part of chlorophyll Aids in formation of sugars
6. Sulfur	Promotes increased root growth Helps maintain dark green color

During absorption, molecules of water and nutrients outside the plant's roots are taken up into the plant. The movement of molecules through permeable membranes is known as diffusion. As water passes through these membranes, it is referred to as osmosis. The movement of water and the flow of larger molecules is caused by pressure differences within the plant known as hydrostatic pressure.

Temperature

Temperature can influence plant growth positively or negatively. Because plants have large surface areas, it is difficult for them to regulate their own temperature. Temperatures above or below the optimum growing temperature of 68° to 95° will reduce carbon fixation within the plant. When temperatures drop, plant processes slow down. Chemical reaction rates also slow down at cooler temperatures. Gaseous exchange decreases, and diffusion and osmosis slow down because the permeability of membranes is more difficult. Colder temperatures reduce the growth rate of plants.

As temperatures rise past the optimum, plant growth is also reduced. As the temperature rises, enzymes become less stable and break down causing plant inactivity. Many processes within the plant are affected by temperatures. Consequently, plant growth is reduced as temperature rises above the optimum. The optimum growing temperature varies for each plant species.

Summary

Understanding the factors that influence plant growth is important to understanding the process of plant growth. The plant kingdom is very dependant upon the environment. The availability of light, clean water, essential nutrients, and optimum temperature all affect plant growth. Humans are equally dependent upon the plant kingdom. Caring for the environment will help to ensure the continued supply of food for the world.

Credits

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