

**A STUDY OF THE EFFECT OF LIGHT INTENSITY ON THE GROWTH  
OF MAIZE (*Zea mays* L.)**



**By**

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**A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF PLANT  
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**FEBRUARY, 2025.**

## CERTIFICATION

We certify that this research work was carried out by **Stafford OLIKIABO** of the Department of Plant Biology and Biotechnology, Faculty of Life Sciences, University of Benin, Benin City, Nigeria.

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## **DEDICATION**

This work is dedicated to God Almighty for His guidance, direction, and strength, as well as to my parents and siblings for their support throughout.

## **ACKNOWLEDGEMENTS**

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## **ABSTRACT**

The aim of the study was to investigate the effect of varying light intensities on the growth and development of *Zea mays* (maize), a staple crop of global importance. The experiment evaluated key growth parameters, including plant height, leaf number, leaf area, chlorophyll content, fresh weight, dry weight, and root development under three distinct light intensity levels: high, medium, and low. The results indicated that high light intensity promotes superior growth, as evidenced by greater biomass accumulation, increased leaf area, taller plants, and higher fresh and dry weights. Conversely, low light intensity results in reduced growth rates but induces an adaptive increase in chlorophyll content to maximize light absorption. Root development was also significantly influenced, with high light intensity supporting robust root systems and low light leading to underdeveloped roots. This study highlights the critical role of light intensity in regulating photosynthesis and overall plant productivity. The findings provide valuable insights for optimizing agricultural practices to enhance maize yield, particularly in environments where natural light is insufficient or inconsistent. Recommendations are made for strategic light management to ensure optimal maize growth in both traditional and controlled cultivation systems.

# CHAPTER ONE

## INTRODUCTION

### 1.1 BACKGROUND STUDY

Plants are eukaryotic organisms belonging to the biological kingdom *Plantae*, characterized by their ability to perform photosynthesis and their rigid cell walls (Marshall, 2004). They are essential to life on Earth, as they produce the oxygen we breathe and provide food for humans and animals. As autotrophs, plants are capable of synthesizing their own nourishment through photosynthesis. This process involves the green pigment chlorophyll within the chloroplasts, which absorbs light energy from the sun, allowing plants to convert water and carbon dioxide into carbohydrates, which are used as food, while releasing oxygen as a byproduct (Akintoye *et al.*, 2011).

*Zea mays*, commonly known as maize or corn, is one of the most important plants for human consumption. It is a staple food crop globally and serves as a source of calories, fiber, and essential nutrients. Beyond its role as a food crop, maize has vast industrial uses, including the production of biofuels, starch, and various derivatives. Its cultivation is widespread, and it is a key crop in agriculture for many countries, serving as both a source of nutrition and economic value.

Plants, particularly maize, occupy a critical position in the food chain, being primary producers that provide nourishment not only to humans but to all living organisms. The products of maize—whether in the form of its grain, biomass, or by-products—serve as essential resources for human survival. Beyond food, plants provide us with air, shelter, clothing, medicine, and

many other materials that enhance the quality of life (Bennett, 2010). As primary producers, plants form the foundation of ecosystems and are essential for maintaining the balance of life on Earth (Fageria *et al.*, 2011).

## **1.2 ENVIRONMENTAL FACTORS AFFECTING MAIZE GROWTH**

The growth and development of *Zea mays* are influenced by environmental factors such as light intensity, temperature, water availability, humidity, and soil nutrients. Among these, light plays a pivotal role in photosynthesis, which drives energy production in plants (Sysoeva *et al.*, 2010). Light intensity directly affects photosynthetic efficiency, influencing maize yields in both natural and controlled environments. Excessive or insufficient light can stress plants, highlighting the need for optimal light conditions to maximize growth (Razzak, 2017).

### **1.2.1 Light Intensity and Photosynthesis in *Zea mays***

The intensity of light plays a central role in the efficiency of photosynthesis in plants. For *Zea mays*, adequate light intensity promotes the proper functioning of chlorophyll, which absorbs light energy to fuel the conversion of carbon dioxide and water into glucose. This process is essential for the growth of leaves, roots, and stems, as well as for the production of flowers and fruit.

Light intensity is often categorized into low, medium, and high levels, and each category can have a different effect on plant growth. At low light intensities, maize may struggle to carry out sufficient photosynthesis, leading to poor growth and reduced yields. Conversely, at excessively high light intensities, plants can experience photo-inhibition, a condition in which too much light damages the photosynthetic machinery of the plant, ultimately limiting its growth (Barnejee *et*

*al.*, 2007). Optimal light intensity, therefore, is key to achieving healthy plant growth and maximizing maize yields.

**The three critical components of light that influence plant growth are:**

- a) **Light Quantity:** The total amount of light that reaches the plant's surface. A higher quantity of light generally increases photosynthetic rates, provided that the intensity is not too high.
- b) **Light Quality:** The spectrum or wavelengths of light that are absorbed by the plant. For maize, blue light promotes vegetative growth, while red light is important for flowering and fruiting.
- c) **Light Duration:** Photoperiods influence the vegetative and reproductive stages of maize growth (*Zhu et al.*, 2014).

Optimizing light intensity and understanding its effects on maize growth are crucial for improving agricultural practices, particularly in areas where natural light may be insufficient or inconsistent. Moreover, research into light intensity can help develop farming strategies that ensure optimal growth conditions for *Zea mays*, resulting in higher yields and better-quality crops.

### **1.2.2 Benefits of Light Intensity to *Zea mays* (Maize)**

One of the most crucial factors for the growth and development of *Zea mays* is light intensity. All plants, including maize, require light for photosynthesis, a process in which light, carbon dioxide, and water are converted into carbohydrates (energy) that the plant uses for its growth, flowering, and grain production (*Zhu et al.*, 2014). Without sufficient light, the plant struggles to produce energy, leading to stunted growth and reduced crop yields.

Light plays an essential role in maize growth and development. It supports photosynthesis, the process by which maize converts light energy into chemical energy. This energy is used to synthesize organic molecules, which serve as building blocks for the plant's growth (Darko *et al.*, 2014). Photomorphogenesis, the influence of light brightness and quality on plant growth, is also critical in maize development. However, very high or low light intensities can negatively affect the plant's growth rate. Light is the primary energy source for photosynthesis in maize, where chlorophyll pigments capture sunlight to initiate the production of glucose and oxygen, vital for growth and survival (Klein, 1992).

### **1.2.3 Photosynthesis and Growth in Maize**

Light intensity directly impacts photosynthesis in maize by influencing both the rate at which the process occurs and the accumulation of energy reserves. These reserves are necessary for maize to sustain vegetative and reproductive growth stages (Sysoeva *et al.*, 2010). Maize, as a C4 plant, efficiently utilizes high light intensities for photosynthesis, contributing to robust vegetative and reproductive growth (Darko *et al.*, 2014).

### **1.2.4 Shoot Development in *Zea mays***

Light influences maize shoot elongation, leaf expansion, and root growth. Moderate light supports a well-developed root system, while extreme light intensities may reduce growth due to stress (Razzak, 2017).

Conversely:

- a) **Low Light:** Results in spindly stems and reduced leaf size, limiting photosynthetic efficiency and overall plant growth.

- b) **Excessive Light:** Increases transpiration rates, potentially causing water stress and impairing shoot development.

### 1.2.5 Root Growth and Light Effects

The root system in maize benefits greatly from moderate light intensity:

- a) **Under Low Light:** Reduced photosynthesis leads to insufficient energy for root growth, resulting in underdeveloped root systems that limit water and nutrient absorption.
- b) **Under Moderate Light:** A deep and branching root system is supported, enhancing nutrient and water uptake efficiency.
- c) **Under High Light:** Excessive transpiration due to high light can stress the plant, reducing root growth and increasing susceptibility to water deficits.

### 1.2.6 Light Intensity and Plant Lifecycle

Maize has specific light intensity requirements that vary based on its growth stage. During its early vegetative stage, moderate light is essential for robust shoot and root development. As the plant progresses to flowering and grain-filling stages, higher light intensities are necessary to support increased energy demands for reproductive growth and grain production (Razzak, 2017).

*Zea mays*, commonly known as maize, has a fascinating relationship with light intensity throughout its plant lifecycle.

#### a) **Seed Germination and Seedling Stage**

Maize plants require adequate light intensity to germinate and develop. Research suggests that high light intensity can enhance germination rates and seedling growth (Singh *et al.*,

2022). However, extremely high light intensity can be detrimental, leading to photoinhibition and reduced growth (Liu *et al.*, 2020).

**b) Vegetative Growth Stage**

During the vegetative growth stage, maize plants require moderate to high light intensity to promote healthy growth and development. Studies have shown that light intensity affects photosynthesis, dry matter production, and dry matter distribution in maize plants (Zhang *et al.*, 2023)

**c) Reproductive Growth Stage**

As maize plants enter the reproductive growth stage, they require high light intensity to support grain filling and yield development. Research has demonstrated that increased light intensity can enhance photosynthetic activity, leading to improved grain yields (Li *et al.*, 2022).

### **1.2.7 Economic and Agricultural Importance**

The economic and agricultural importance of *Zea mays* (commonly known as maize or corn) is significant across many dimensions, ranging from its role in food production to its diverse uses in industrial applications.

**A. Economic Importance**

- i. **Global Food Crop:** Maize is one of the world's most cultivated crops, being a staple in the diets of millions of people. It is the third most produced crop worldwide, after rice

and wheat (FAO, 2021). In countries such as the United States, China, Brazil, and Mexico, maize forms a fundamental part of the food supply.

For instance, maize is a vital part of the food security system in sub-Saharan Africa and Latin America, where it constitutes a significant portion of daily nutrition (Sheahan & Barrett, 2017). Its grains are consumed directly as food, while the processed form (cornmeal) is integral to making tortillas, polenta, and other regional dishes.

- ii. **Animal Feed:** Maize is a primary ingredient in animal feed, especially for livestock such as cattle, poultry, and pigs. It accounts for approximately 50% of the total animal feed production globally (FAO, 2021). The crop's high energy content and digestibility make it essential in the production of meat, milk, and eggs.
- iii. **Biofuels:** The growing interest in renewable energy sources has also bolstered the economic significance of maize, particularly in the production of ethanol. In the United States, a substantial portion of maize is used to produce ethanol for fuel, contributing to the country's energy independence and reducing its reliance on fossil fuels. Maize-based ethanol accounts for about 40% of the maize production in the U.S. (Liska *et al.*, 2014).
- iv. **Industrial Uses:** The industrial uses of maize go beyond food and fuel. Its derivatives are used in the production of a wide variety of products, such as plastics, adhesives, and pharmaceuticals. Cornstarch, a byproduct of maize, is a key ingredient in many food and non-food items. The global market for maize-based products like corn syrup and high-fructose corn syrup is vast, impacting industries ranging from beverages to processed foods.

- v. **Economic Impact in Developing Countries:** For countries in sub-Saharan Africa and parts of Latin America, maize is an important economic crop. It is the primary crop grown by many smallholder farmers and is central to the agricultural economy. In addition to its use for food, its economic value stems from the local trade in maize, which supports millions of livelihoods (Bouis *et al.*, 2011).

## **B. Agricultural Importance**

- i. **Versatility and Adaptability:** Maize is a highly adaptable crop that can be grown in a wide variety of climates, from temperate to tropical regions. It is relatively drought-resistant, especially in hybrid varieties, and can thrive in different soil types (Moser *et al.*, 2021). This adaptability makes it a crucial crop for both large-scale commercial agriculture and smallholder farming.
- ii. **High Yield Potential:** Maize is a high-yield crop, especially with the use of hybrid varieties and modern agricultural practices. In developed countries, yields can reach over 10 tons per hectare, while in developing countries, the yields can be significantly lower. However, efforts to improve local agricultural practices and the introduction of better seed varieties are enhancing productivity globally (Kassie *et al.*, 2015).
- iii. **Soil Health:** Although maize is a nitrogen-demanding crop, its cultivation can contribute to soil fertility if managed properly, such as with crop rotation and the application of organic matter (FAO, 2021). However, excessive reliance on maize monoculture farming can lead to soil degradation, highlighting the need for sustainable agricultural practices.
- iv. **Genetic and Breeding Importance:** Maize has also become a model organism for genetic studies and breeding programs due to its relatively simple genetic structure.

The availability of diverse maize varieties and the mapping of the maize genome have enabled advances in breeding techniques aimed at improving yield, disease resistance, and drought tolerance. These advances are crucial for ensuring global food security, especially in regions that face climate variability (Flint-Garcia *et al.*, 2009).

The economic and agricultural importance of *Zea mays* is vast, touching various sectors, including food security, animal agriculture, biofuels, and industrial products. It is a vital crop that supports livelihoods, generates income, and helps feed a significant portion of the world's population. The challenges of climate change, soil degradation, and population growth will require continued innovation and research into maize cultivation and its various uses.

### **1.3 BOTANY OF *Zea mays* (Maize)**

Maize, scientifically known as *Zea mays*, is one of the most important cereal crops globally, originating in Central America over 7,000 years ago. It belongs to the grass family (Poaceae) and is now grown in diverse climates around the world. Maize plants typically grow tall, with sturdy stems, long narrow leaves, and large ears that house the kernels, which vary in color from yellow to red, blue, and even black. Maize thrives in warm, sunny climates with well-drained soil and ample rainfall. It is a highly versatile crop, used not only as a staple food for humans but also as livestock feed, biofuel (ethanol), and in numerous industrial products. The kernels are rich in carbohydrates and provide a significant source of energy. Different varieties of maize, including sweet corn, dent corn, and popcorn, are cultivated for various purposes. Its adaptability and high yield make it a key agricultural product, contributing to food security and economic stability in many countries.

### **1.3.1 Scientific Classification**

**Kingdom:** Plantae

**Subkingdom:** Viridiplantae

**Super Division:** Embryophyta

**Division:** Tracheophyta

**Subdivision:** Spermatophytina

**Class:** Angiospermae

**Order:** Poales

**Family:** Poaceae

**Genus:** *Zea*

**Species:** *Zea mays*

**Common Names:** Maize, corn

### **1.3.2 Origin**

The origin of *Zea mays*, is a topic of significant interest due to its economic and agricultural importance. Maize is considered one of the most widely cultivated crops globally, serving as a staple food and raw material for numerous industries, including food, animal feed, biofuels, and bioplastics. Understanding its domestication and origin is crucial for improving current breeding practices and understanding its genetic diversity.

The domestication of maize is believed to have occurred in the central regions of Mexico around 9,000 years ago. Genetic and archaeological evidence supports the idea that maize evolved from

its wild ancestor, *Zea mays* ssp. *parviglumis*, a grass species native to southern Mexico. Unlike modern maize, *Zea mays* ssp. *parviglumis* produced small, hard kernels encased in tough husks. Early human populations in Mesoamerica gradually selected for larger, more robust ears of corn with softer kernels, which eventually led to the evolution of the maize plant we recognize today (Matsuoka *et al.*, 2002).

Recent genetic studies have provided additional clarity on the evolutionary path of maize. One study by **Samantara *et al.* (2022)** suggested that modern maize is a product of both natural selection and human-driven breeding processes. Over the millennia, maize has adapted to a wide range of climatic and soil conditions through complex genetic selection processes. Researchers have examined DNA markers to identify specific genes linked to domestication traits such as increased kernel size, reduced seed dispersal, and enhanced resistance to diseases and pests.

One of the key traits that distinguish maize from its wild ancestor is the genetic modification of the *teosinte* gene, which is responsible for the plant's branching and ear development. Studies have shown that the domestication process involved selective pressure for a reduced number of branches, leading to a more productive and easier-to-harvest plant structure (Doebley *et al.*, 2006). The gene responsible for ear shattering, which is a wild trait that allows seeds to disperse, was also suppressed in maize during domestication, resulting in a non-shattering ear—an essential trait for farming (Wang *et al.*, 2005).

The transition from *Zea mays* ssp. *parviglumis* to modern maize was likely facilitated by early agricultural practices such as seed saving and selective planting. These human interventions contributed to the genetic bottleneck that formed the modern maize lineage and set it apart from its wild relatives.

After its domestication in Mesoamerica, maize spread rapidly across the Americas. The crop was introduced to other regions of the world following European exploration and colonization. By the 17th century, maize had reached Europe, Asia, and Africa, becoming a globally important crop. Its rapid adoption and adaptation to diverse climates have been a testament to its versatility and resilience.

Through trade, exploration, and migration, maize has become an integral crop in various parts of the world. It now plays an essential role in both the food security of developing nations and as a high-value commodity in industrialized countries. In fact, today, the United States, China, Brazil, and Argentina are among the largest producers of maize worldwide.

The origin of maize also underscores the importance of its wild relatives in modern breeding programs. *Zea mays* ssp. *parviglumis* remains a valuable genetic resource, as it contains traits that are beneficial for disease resistance, drought tolerance, and pest management. Modern breeders are increasingly looking to these wild relatives for their resilience in the face of climate change and evolving agricultural challenges (Samantara *et al.*, 2022).

In addition to its wild ancestors, maize's adaptation to diverse growing conditions is partly due to the hybridization of various maize varieties. The continued use of wild maize species in breeding programs will likely contribute to the future improvement of maize for food security, environmental sustainability, and yield optimization.

The domestication of *Zea mays* is a fascinating example of how human agricultural practices can shape the evolution of plant species. Its origins in southern Mexico, followed by selective breeding over millennia, led to the crop we rely on today. Through continued research and understanding of maize's genetic background, scientists aim to ensure that this vital crop can

withstand future environmental pressures and continue to provide food, fuel, and industrial products globally.

### 1.3.3 Botanical Description

*Zea mays* is a tall, annual grass that typically grows to heights of 2–3 meters under optimal conditions. The plant has a robust, jointed stem with a series of nodes and internodes. Its leaves are large, lanceolate, and arranged alternately, with a distinct midrib running along their length. The inflorescence consists of separate male (tassel) and female (ear) structures.

- i. **Male Flowers:** Found in the terminal tassel.
- ii. **Female Flowers:** Develop in the leaf axils, forming the cob.
- iii. **Fruit:** The fruit is a kernel, which varies in size, shape, and color, depending on the maize variety.

The root system is fibrous, with secondary roots providing support and nutrient uptake. Maize exhibits C4 photosynthesis, making it highly efficient in converting light energy under high-temperature and light-intensity conditions (Beadle, 1937).

### 1.3.4 Uses of maize

*Zea mays* is a versatile crop with wide-ranging uses:

- a) **Food:** Maize is a staple food globally, used in fresh, dried, or processed forms such as cornmeal, tortillas, and popcorn.
- b) **Feed:** A major source of animal feed, maize is used in silage and grain-based feeds.
- c) **Industrial Applications:** Corn is used in ethanol production, bioplastics, and bioenergy.

The starch is widely applied in the food and paper industries.

- d) **Cultural Significance:** Maize holds symbolic importance in many cultures, particularly in the Americas, where it is considered sacred.

### 1.3.5 Nutritional Properties of maize

Maize kernels are rich in carbohydrates, primarily starch, and serve as an energy-dense food.

The nutritional properties of *Zea mays* (maize) make it a crucial crop in global food systems. As a staple food, maize is widely consumed in various forms, including grains, flour, oil, and processed products. Maize is an essential dietary component, particularly in regions where other sources of protein and carbohydrates are scarce. Its versatility in the kitchen, combined with its impressive nutritional profile, contributes to its widespread adoption.

The primary macronutrients in maize include carbohydrates, proteins, and fats. Maize is predominantly composed of carbohydrates, providing a high-energy source. On average, maize contains about 70-75% carbohydrates, mainly in the form of starch, which is essential for providing energy. Starch is easily digestible and a crucial component in human diets.

- a) **Carbohydrates:** The starch content in maize is significant, providing about 70-75% of the grain's weight. This high carbohydrate content makes maize an excellent source of energy. In addition to starch, maize also contains small amounts of sugars, which contribute to its sweet taste when consumed in certain varieties like sweet corn (Gibson *et al.*, 2020).
- b) **Proteins:** Maize contains about 8-11% protein by weight, but it is relatively low in certain essential amino acids, particularly lysine and tryptophan. As a result, maize protein is often considered incomplete, lacking in some of the key amino acids necessary for human health. However, maize proteins can be complemented with other plant-based

protein sources (e.g., legumes), improving their overall nutritional value (Haug & Lantzsch, 2019).

- c) **Fats:** Maize is also a source of fat, with an average fat content of about 3-5%. The fat composition is primarily made up of unsaturated fats, particularly polyunsaturated fats like omega-6 fatty acids. Additionally, maize oil, extracted from the germ, is a common cooking oil, offering a high percentage of linoleic acid (about 55-60%), which is beneficial for cardiovascular health (Haug & Lantzsch, 2019).

In addition to macronutrients, maize is rich in several important micronutrients, including vitamins and minerals, which contribute to its role as a critical part of human diets.

- d) **Vitamins:** Maize is an excellent source of several B vitamins, particularly B1 (thiamine), B3 (niacin), and B5 (pantothenic acid), all of which are essential for energy metabolism and overall cellular function. A deficiency in these vitamins can lead to neurological disorders and impaired growth. However, maize is relatively low in vitamins A and C, which are vital for immune health and antioxidant activity (Bertoli *et al.*, 2021). In regions where maize is a primary food source, the addition of nixtamalization (an alkali treatment process) can improve the bioavailability of niacin, preventing conditions like pellagra, which results from niacin deficiency (Gibson *et al.*, 2020).
- e) **Minerals:** Maize contains a moderate amount of essential minerals, including magnesium, phosphorus, and potassium. These minerals play a key role in bone health, cellular function, and electrolyte balance. However, maize is relatively low in iron and zinc, which are important for immune function and metabolic processes. This deficiency

can lead to conditions like iron deficiency anemia, especially in populations that rely heavily on maize as a primary food source (Zhao *et al.*, 2020).

- f) **Antioxidants and Phytochemicals:** Maize is a rich source of antioxidants, especially in varieties with pigmented kernels, such as red, purple, and blue maize. These pigmented varieties contain anthocyanins, carotenoids, and other polyphenolic compounds that offer protection against oxidative stress, inflammation, and certain chronic diseases (Bertoli *et al.*, 2021). The antioxidant properties of maize have made it a subject of growing interest in both health and agricultural research, as these compounds are known to contribute to the prevention of conditions like cancer, cardiovascular diseases, and neurodegenerative disorders.

Maize provides numerous health benefits, particularly due to its high fiber content, which is important for digestive health. Fiber aids in regulating bowel movements, reducing the risk of constipation, and may help lower cholesterol levels. The fiber in maize also helps stabilize blood sugar levels, making it a valuable food for people with diabetes or those looking to manage their blood sugar (Santos *et al.*, 2020).

Maize's high starch content is converted into glucose in the body, making it an effective source of quick energy. This property makes it an excellent food choice for athletes and individuals engaging in strenuous physical activities. However, due to its relatively high glycemic index (GI), it should be consumed in moderation, particularly for individuals with insulin resistance or those at risk for diabetes (Santos *et al.*, 2020).

While maize is generally safe to consume, there are some potential health concerns related to its processing and consumption. For instance, maize that is not processed through nixtamalization

may contribute to niacin deficiency in vulnerable populations, particularly in regions where maize is a staple food. Additionally, maize-based diets that are not balanced with other nutrient-rich foods may lead to malnutrition, especially in terms of essential amino acids, vitamins, and minerals (Zhao *et al.*, 2020).

There are also concerns about the presence of mycotoxins in maize, such as aflatoxins, which are produced by mold species that can grow on maize under certain environmental conditions. Aflatoxins are toxic and carcinogenic, and their presence in maize can pose serious health risks. To mitigate these risks, maize should be stored properly and monitored for contamination, especially in regions with high humidity and temperature (Haug & Lantzsich, 2019).

The nutritional properties of *Zea mays* make it a highly valuable crop worldwide. Its carbohydrate-rich content provides energy, while its vitamins and minerals contribute to essential metabolic processes. The protein content, although incomplete, can be complemented with other food sources for a balanced diet. Furthermore, maize's antioxidant properties and fiber content offer important health benefits. However, the potential for mycotoxin contamination and the risk of malnutrition in maize-dominated diets necessitate proper processing and consumption strategies. As a result, *Zea mays* remains a critical food source, particularly in developing regions, and is integral to global food security.

### **1.3.6 Ecology**

*Zea mays* is highly adaptable to a variety of climates and altitudes, thriving in regions with adequate sunlight and temperatures between 21°C and 30°C. The plant requires moderate rainfall (500–1200 mm annually) and prefers well-drained, fertile soils with a pH between 5.5 and 7.0. Its adaptability to different environments makes it a globally dominant cereal crop. The ecology of *Zea mays* (maize) is crucial for understanding how this crop interacts with its environment and how

agricultural practices can be optimized for sustainable cultivation. Maize is grown in diverse environments across the globe, from temperate to tropical climates, and it has developed a range of adaptive mechanisms to thrive in these conditions. The ecological success of maize is closely linked to its adaptability, resilience, and response to factors such as soil quality, water availability, temperature, pests, and diseases.

Maize is a warm-season crop, which means it requires a relatively warm climate for optimal growth. It is best suited for regions with temperatures between 18°C and 32°C (64°F to 90°F). Maize is highly sensitive to frost, and temperatures below 10°C (50°F) during its growing season can significantly reduce yield and growth. In general, maize thrives in climates with moderate to high annual precipitation, although it can tolerate drought for short periods.

- a) **Temperature:** Maize requires a growing season of about 100 to 150 frost-free days, depending on the variety. Optimal temperatures for maize growth are between 20°C and 30°C (68°F to 86°F), with temperatures above 35°C (95°F) potentially causing heat stress and reducing pollination success.
- b) **Rainfall:** Maize requires an adequate water supply, particularly during the pollination phase. It needs about 500 to 800 millimeters of water per growing season. While maize can withstand some drought conditions, prolonged water stress during critical growth stages can lead to significant reductions in yield (Sah, 2021).
- c) **Soil:** Maize grows best in well-drained, fertile soils with a pH range of 5.8 to 7.0. It prefers loamy soils rich in organic matter, which allows for better root development and nutrient uptake. Maize is sensitive to waterlogging, which can impair root function and reduce growth. Therefore, proper drainage is essential for successful maize cultivation.

Maize's ecological success is partly due to its ability to adapt to diverse environmental conditions. Over the centuries, maize has been cultivated in a variety of climates, from the dry highlands of Mexico to the humid lowlands of Southeast Asia. Several factors contribute to maize's ecological adaptability:

- I. **Root System:** The root system of maize is fibrous and can extend deep into the soil, enabling it to access water and nutrients from various soil layers. This makes maize resilient to moderate drought conditions, as its roots can access deeper groundwater sources.
- II. **Leaf Morphology:** The large, broad leaves of maize play an important role in maximizing photosynthesis. Maize plants can adjust their leaf orientation to reduce heat stress and optimize light capture during the growing season. Additionally, maize has a C4 photosynthetic pathway, which is highly efficient in converting carbon dioxide into sugars, especially under high temperatures and low water availability (Sah, 2021).
- III. **Temperature Tolerance:** Maize varieties have different temperature tolerances. Tropical varieties are better suited for high temperatures and shorter growing seasons, while temperate varieties are more suited for cooler climates. Breeding efforts have also focused on developing maize varieties that can tolerate both heat stress and water stress (Bernardo, 2020).
- IV. **Flowering and Pollination:** Maize is an outcrossing species, meaning that it relies on wind pollination. This feature is significant in its ecological adaptation as it allows for cross-pollination, increasing genetic diversity. However, maize is highly sensitive to environmental stresses during flowering. Factors such as high temperatures, drought, and

poor soil conditions during flowering can result in poor pollination, leading to reduced yields (Bernardo, 2020).

Maize interacts with a wide range of other organisms in its ecosystem. These interactions can be both beneficial and detrimental to the crop.

- a) **Symbiotic Relationships:** Maize plants form symbiotic relationships with soil microbes such as mycorrhizal fungi, which enhance nutrient absorption, particularly phosphorus. This mutualistic relationship helps maize thrive in soils with low nutrient availability (Smith & Read, 2021). Additionally, certain bacteria in the rhizosphere can protect maize roots from pathogens and enhance nutrient uptake.
- b) **Pests and Diseases:** Maize is susceptible to a variety of pests and diseases, which can significantly impact yields. Common maize pests include the European corn borer (*Ostrinia nubilalis*), fall armyworm (*Spodoptera frugiperda*), and maize weevil (*Sitophilus zeamais*). These pests damage the plant by feeding on its leaves, stalks, and kernels. Maize is also affected by diseases such as maize rust, gray leaf spot, and the maize lethal necrosis virus, which can reduce plant vigor and yield (Gurney *et al.*, 2019).
- c) **Competition with Weeds:** Maize competes with weeds for resources such as water, nutrients, and sunlight. Effective weed control is crucial in maize farming to ensure high yields. Herbicides, crop rotation, and intercropping with other species are commonly used practices to minimize weed competition.
- d) **Beneficial Insects:** Maize fields also host beneficial insects such as pollinators and natural predators of pests. For example, ladybugs and parasitoid wasps help control

aphids and caterpillar pests, reducing the need for chemical pesticides (Bourguet *et al.*, 2020).

Climate change poses significant challenges to maize production due to changes in temperature, precipitation patterns, and the frequency of extreme weather events. Higher temperatures, increased frequency of droughts, and unpredictable rainfall patterns can adversely affect maize growth, particularly in regions where the crop is already under stress. Studies predict that climate change may reduce maize yields by up to 30% in some regions by 2050, particularly in developing countries that rely heavily on maize as a staple food (Lobell *et al.*, 2011).

To mitigate these impacts, maize breeders are developing climate-resilient varieties that are more tolerant of heat, drought, and pests. Furthermore, agricultural practices such as conservation tillage, efficient water management, and integrated pest management (IPM) can help maintain maize yields under changing climate conditions (Bertin *et al.*, 2020).

The ecology of *Zea mays* reveals the complex interactions between maize and its environment. From its adaptability to different climates and soil types to its reliance on symbiotic relationships with soil microbes, maize has evolved to thrive in diverse ecosystems. However, it also faces significant ecological challenges, including pests, diseases, and the impacts of climate change. Understanding these ecological dynamics is essential for developing sustainable maize farming practices and ensuring food security in the face of global challenges.

### **1.3.7 Cultivation**

Maize cultivation involves the following steps:

1. **Land Preparation:** Soil is plowed and leveled for optimal seedbed preparation.

2. **Sowing:** Seeds are planted in rows with 60–75 cm spacing and a depth of 3–5 cm, depending on soil type.
3. **Fertilization:** Nitrogen, phosphorus, and potassium fertilizers are commonly used to boost crop yields. Organic manures, such as cow dung or compost, may also be applied.
4. **Irrigation:** Adequate water supply during critical growth stages (e.g., tasseling and grain filling) is essential for optimal yields.
5. **Weeding:** Regular weeding and pest control practices are necessary to prevent yield loss.
6. **Harvesting:** Typically occurs when kernels reach physiological maturity, indicated by black layers at the base of the kernels.

Modern maize farming often incorporates genetically modified (GM) varieties for enhanced pest resistance, drought tolerance, and yield potential (Dowswell *et al.*, 1996).

#### **1.4 LITERATURE REVIEW**

Studies have consistently shown that light intensity significantly impacts maize growth. For example, Ologundudu *et al.* (2013) demonstrated that *Zea mays* performs optimally under adequate light conditions. Similarly, Razzak (2017) highlighted the effects of light extremes on maize growth, noting reductions in photosynthesis and biomass under both low and excessive light intensities. Ologundudu *et al.* (2013) conducted a study aimed at analyzing the effects of light stress on germination and growth parameters of *Zea mays*, *Celosia argentea*, *Amaranthus cruentus*, *Abelmoschus esculentus*, and *Delonix regia*. The results of the study indicated that light stress significantly impacted the germination, growth, and development of plants. The findings revealed that seeds of *Amaranthus cruentus* and *Zea mays* germinated better under light

conditions. However, the germination of *Celosia argentea* and *Abelmoschus esculentus* showed variation between light and dark treatments. In contrast, seeds of *Delonix regia* germinated better in the dark. These observations suggest that *Amaranthus cruentus* and *Zea mays* are better adapted to light conditions, whereas *Delonix regia* thrives in dark conditions.

### **1.5 AIM OF THE PROJECT**

The aim of this research is to determine the effect of different light intensities on the growth of *Zea mays*.

### **1.6 OBJECTIVES OF THE PROJECT**

The specific objectives of the research are:

- a) To determine the effect of light intensity on plant height.
- b) To measure the leaf area under varying light conditions.
- c) To evaluate the number of leaves produced under varying light conditions.

## **CHAPTER TWO**

### **MATERIALS AND METHODS**

#### **2.1 STUDY LOCATION**

The study was conducted within the premises of the Faculty of Life at the University of Benin, Benin City, Edo State.

#### **2.2 EXPERIMENTAL DESIGN**

Sand was collected at the oil palm plantation beside the Tetfund hostel after Hall 6, University of Benin, Benin City. The sand was transferred into fifteen plastic pots containing holes at the bottom to allow for drainage during the course of the experiment. Seedlings of *Zea mays* were transplanted into experimental pots (30 cm in diameter) that were previously filled with sand.

The plants were exposed to three light levels: medium light intensity (plants grown under vegetation canopy)  $0.98 \times 10$  lux, low light intensity (plants grown in a screen house)  $0.28 \times 10$  lux, and high light intensity (plants exposed to full solar radiation)  $1 \times 10$  lux. The seedlings were watered four times a week with 60 cl of sachet water each morning until they were fully established. After transplanting the seedlings, the pots were divided into three different batches. Each treatment had five replicates.

The experimental design for this study was a completely randomized design. This approach was used to block all sources of variability and error that could arise as a result of environmental factors and other systemic factors.

## **2.3 DATA COLLECTION**

### **2.3.1 Stem Height Measurement**

The height of the stem of the growing plant was measured using a meter rule in centimeters from soil level to the terminal bud. This measurement spanned six weeks.

### **2.3.2 Leaf Number Determination**

The number of leaves produced by the plant at different light zones was determined quantitatively by counting using visual observation. This was carried out for six weeks.

### **2.3.3 Fresh and Dry Weight Determination**

The fresh and dry weight of the test plant *Zea mays* was determined after six weeks of treatments under varying light intensities. The leaves, stems, flowers, and roots of the plants were retrieved and cleaned to remove soil by immersing them in water and rinsing carefully. These parts were then dried using tissue paper to remove excess water before weighing, ensuring accurate measurements and avoiding parallax error. Plain papers were used to measure the different parts of the plants and were labelled accordingly. The fresh weight of the various plant parts collected from each replicate was measured using an electronic balance. The weight of one plain paper was subtracted from the total weight of each plant part to obtain precise readings.

The samples with fresh weights recorded were then dried using an oven set to a temperature of 80°C for 24 hours. Once dried, the samples were weighed again using an electronic balance to determine the dry weight values, recorded in grams. The dry matter content was calculated using the following formula:

### 2.3.4 Determination of Leaf Area

The leaf area of *Zea mays* was determined using the graph sheet method as described by Eze (1965). At the end of the experiment, the leaf area was measured by tracing the outlines of the leaves onto graph sheets. The cut-out areas were then compared with a standard paper of known weight-to-area ratio using the following relationship:

For example, if a specimen weighs 2 grams, the standard area is 100 cm<sup>2</sup>, and the standard area weight is 1 gram, the calculation would be:

This method provided an accurate determination of the leaf area for the treated plants under varying light conditions.

$$\text{Leaf Area} = \frac{\text{Specimen} \times \text{Standard Area}}{\text{Standard Area Weight}}$$

### 2.3.6 Statistical Analysis

The values presented in the tables are those of mean and standard error of means (S.E.M) of the results of three replicates of *Zea mays* taken for six weeks. The standard error value was obtained using this formula:

The standard error value was obtained using this formula:

$$S_x = \frac{S^2}{n}$$

Where  $S_x$  = Standard error

$S^2 = \text{Variance}$

$n = \text{number of replication.}$

Where:

- Standard error =  $S$
- Variance =  $X$
- Number of replication

## CHAPTER THREE

### RESULTS

This study investigated the effect of different light intensities on the growth and development of *Zea mays*, focusing on plant biomass, leaf number, plant height, and leaf area. The results consistently demonstrate that light intensity significantly impacts the growth performance of *Zea mays*.

The fresh and dry weights of the leaves, stems, and roots of *Zea mays* showed marked differences across the three light intensities (Tables 3.1 and 3.2). High light intensity (50,000 lux) yielded the highest fresh and dry weights, with leaves, stems, and roots recording 34.48 g, 45.32 g, and 41.10 g (fresh weight) and 15.36 g, 19.98 g, and 18.36 g (dry weight), respectively. These results indicate that sufficient light availability enhances photosynthesis and biomass accumulation in all plant parts.

In contrast, medium light intensity (25,000 lux) significantly reduced the fresh and dry weights of plant parts. Fresh weights for leaves, stems, and roots were 5.88 g, 3.67 g, and 1.65 g, while dry weights were 2.82 g, 1.56 g, and 0.75 g, respectively. This suggests that while plants can grow under moderate light conditions, their energy production and resource allocation are restricted compared to high light conditions.

Under low light intensity (16,000 lux), the fresh and dry weights of all plant parts were the lowest, with leaves, stems, and roots recording 2.88 g, 1.85 g, and 0.90 g (fresh weight) and 1.26

g, 0.83 g, and 0.38 g (dry weight), respectively. These findings reflect a severe limitation in energy generation, resulting in poor growth and biomass accumulation.

Light intensity also influenced the number of leaves and plant height over four weeks (Tables 3.3 and 3.4). Under high light intensity, the number of leaves increased steadily, from 6.17 leaves at 1WAT to 9 leaves at 4WAT, with plant height increasing from 19.33 cm to 52.00 cm over the same period. These results highlight optimal growth and development due to ample light availability for photosynthesis and cell division.

In medium light intensity, the number of leaves decreased from 6.33 at 1WAT to 5.17 at 4WAT, while plant height increased more modestly, from 27.66 cm to 44.17 cm. This reflects a reduced capacity to support new growth under limited light.

Under low light intensity, both the number of leaves and plant height were significantly restricted. Leaf numbers decreased slightly, from 5 leaves at 1WAT to 4.67 leaves at 4WAT, while plant height increased marginally, from 18.16 cm to 26.67 cm. These results confirm that insufficient light hinders vegetative development and overall growth.

Leaf area (Table 3.5) was highest under high light intensity, with leaves recording an average area of 113.68 cm<sup>2</sup>. In medium light, leaf area dropped significantly to 46.42 cm<sup>2</sup>, while low light conditions resulted in the smallest leaf area of 30.00 cm<sup>2</sup>. The reduced leaf area under low light reflects limited photosynthetic capacity and resource allocation.

The results demonstrate that *Zea mays* exhibits optimal growth and development under high light intensity (50,000 lux), with marked reductions in biomass, leaf number, plant height, and leaf area under medium and low light conditions. These findings underscore the critical role of light

intensity in supporting photosynthesis, energy production, and plant growth. While *Zea mays* can adapt to moderate light levels, its growth potential is significantly constrained under low light conditions. This study highlights the importance of optimizing light conditions for maximizing the productivity of *Zea mays*

**Table 3.1:** Fresh weight of *Zea mays* under different light intensities

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<b>Fresh Weight of Plants Parts (g)</b>			
Light Intensity	Leaf	Stem	Root
High (50, 000 lux)	34.48 ± 2.5	45.32 ± 3.8	41.10 ± 5.9
Medium(25,000 lux)	5.88 ± 0.6	3.67 ± 0.2	1.65 ± 0.4
Low (16, 000 lux)	2.88 ± 0.4	1.85 ± 0.3	0.90 ± 0.1

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Values measured as mean ±standard error(SEM).

**Table 3.2:** Dry Weight of *Zea mays* under different light intensities

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<b>Dry Weight of Plants Parts (g)</b>			
Light Intensity	Leaf	Stem	Root
High (50, 000 lux)	15.36 ± 1.6	19.98 ± 1.0	18.36 ± 2.5
Medium(25,000 lux)	2.82 ± 0.2	1.56 ± 0.09	0.75 ± 0.1
Low (16, 000 lux)	1.26 ± 0.1	0.83 ± 0.1	0.38 ± 0.06

Values measured as mean ±standard error(SEM).

**Table 3.3:** Effect of light regime on the mean number of *Zea mays* leaves

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<b>Leaf number of Plants</b>				
<b>Light Intensity</b>	<b>1WAT</b>	<b>2WAT</b>	<b>3WAT</b>	<b>4WAT</b>
High (50, 000 lux)	6.17 ± 0.3	6.5 ± 0.3	8.17 ± 0.3	9.00 ± 0.3
Medium(25,000 lux)	6.33 ± 0.3	5.00 ± 0.3	4.67 ± 0.2	5.17 ± 0.3
Low (16, 000 lux)	5.00 ± 0.3	5.00 ± 0.3	4.50 ± 0.3	4.67 ± 0.2

Values measured as mean ±standard error(SEM).

**Table 3.4:** Effect of light intensity on the height of *Zea mays* leaves

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<b>Plants height (cm)</b>				
<b>Light Intensity</b>	<b>1WAT</b>	<b>2WAT</b>	<b>3WAT</b>	<b>4WAT</b>
High (50, 000 lux)	19.33 ± 1.5	36.50 ± 1.5	49.50 ± 1.0	52.00 ± 1.0
Medium(25,000 lux)	27.66 ± 1.2	37.16 ± 1.1	42.17 ± 1.2	44.17 ± 0.9
Low (16, 000 lux)	18.16 ± 1.1	19.67 ± 1.1	23.83 ± 1.5	26.67 ± 1.2

Values measured as mean ±standard error(SEM).

WAT = Weeks After Treatment

**Table 3.5:** Effect of light regime on leaf area of *Zea mays*

Light Intensity	Leaf area (cm)
High (50, 000 lux)	113.68 ± 6.5
Medium(25,000 lux)	46.42 ± 4.9
Low (16, 000 lux)	30.00 ± 2.0

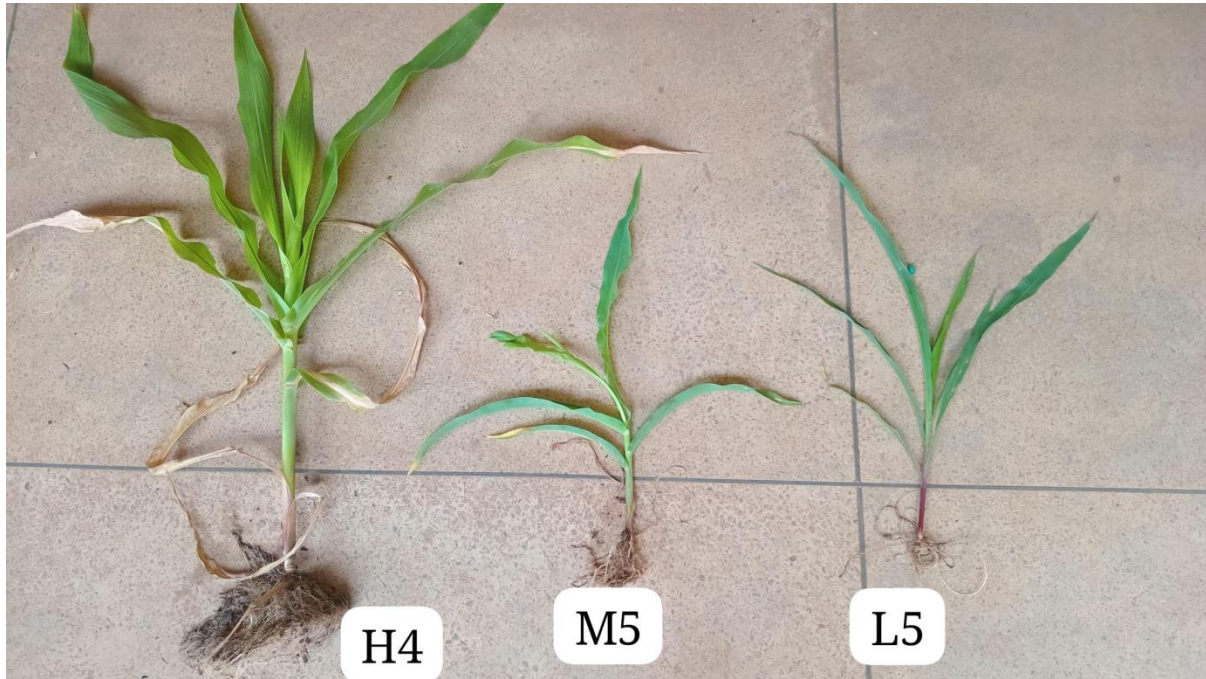
Values measured as mean ±standard error(SEM).

Root development, often overlooked in growth studies, played a critical role in this experiment. Plate 3.1 shows how high light intensity (H4) supported vigorous root growth, as evidenced by the greater root biomass in H4 plants. This can be attributed to the increased energy availability for root elongation and nutrient uptake, which complements shoot growth and enhances overall plant performance.

Conversely, low light intensity (L5) significantly reduced root biomass, reflecting the energy trade-offs plants make under resource-limited conditions. Reduced root growth under L5 likely constrained water and nutrient acquisition, further limiting shoot development. The strong correlation between root and shoot growth underscores the systemic impact of light intensity on plant development.

Plate 3.2, clearly demonstrate the impact of light intensity on various growth parameters in *Zea mays*. High light intensity (H4) promotes superior growth, with higher fresh weight, dry weight, leaf number, plant height, and leaf area. This is consistent with the known role of light in photosynthesis, where more light results in more energy for growth.

In contrast, low light intensity (L5) results in reduced plant growth, though it triggers an increase in chlorophyll content as an adaptive mechanism. This increase in chlorophyll allows plants to maximize the use of the available light, despite the overall growth limitations imposed by the reduced light intensity.



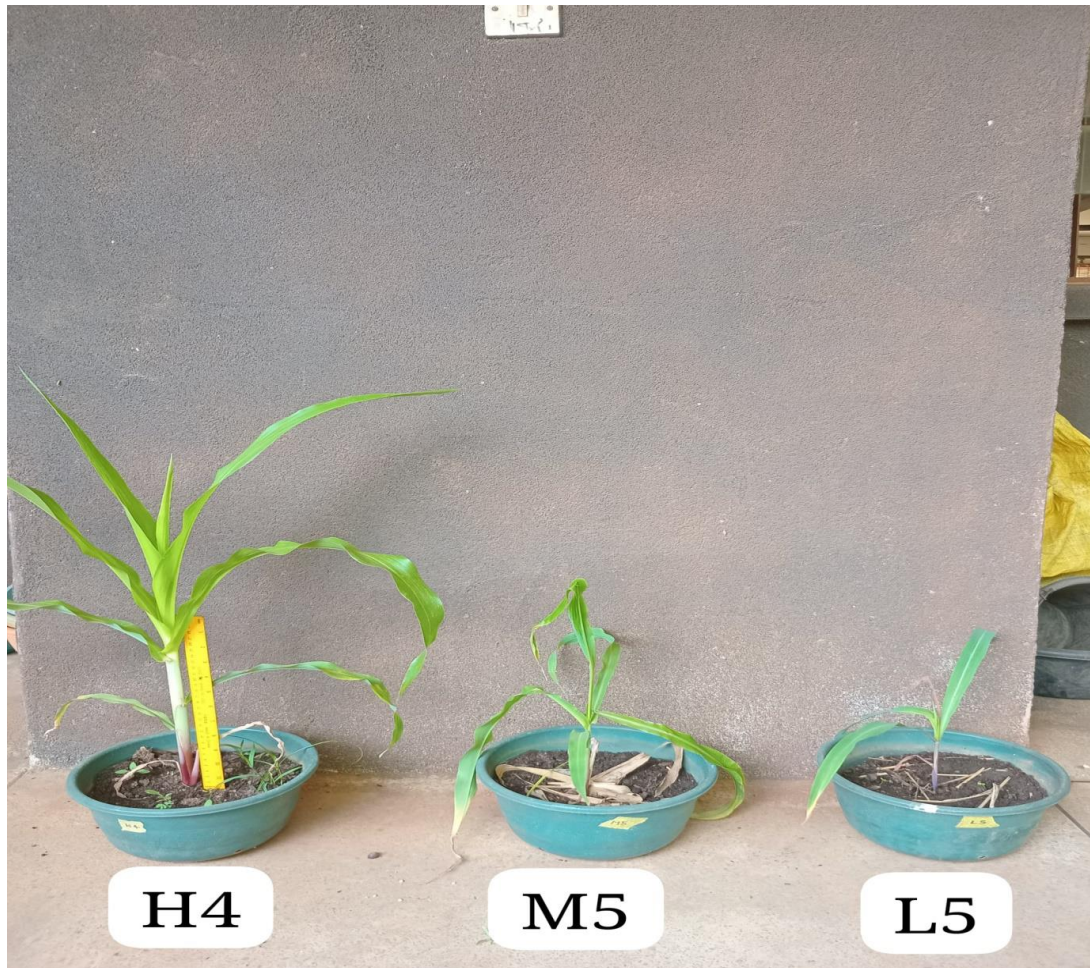
**Plate 3.1:** Root development of *Zea mays* under different light intensities

**Legend**

H4: High light intensity grown plant

M5: Medium light intensity grown plant

L5: Low light intensity grown plant



**Plate 3.2:** Growth habit of *Zea mays* grown at three light levels

**Legends**

H4: High light intensity grown plant

M5: Medium light intensity grown plant

L5: Low light intensity grown plant

## CHAPTER FOUR

### DISCUSSION

The experiment demonstrated the significant effects of varying light intensities on the growth parameters of *Zea mays*. This study investigated how different light intensities (high, medium, and low) influenced key growth metrics such as fresh weight, dry weight, chlorophyll content, leaf number, plant height, and leaf area. As observed, the growth responses varied significantly across the different light treatments, with high light intensity promoting superior growth compared to lower light intensities.

Similar to previous studies, it was observed that light intensity played a pivotal role in promoting plant growth and development. High light intensity (H4) had a significant positive effect on both fresh and dry weights of *Zea mays*, aligning with the work of De Pinheiro Henriques and Marcelis (2000), who suggested that plant physiological activities, including photosynthesis, are directly influenced by light intensity. Plants exposed to H4 exhibited the highest fresh and dry weights, indicating that high light intensity supports greater metabolic activity, leading to enhanced growth and biomass accumulation. This was also confirmed by Ologundudu *et al.* (2013), who reported that crops exposed to direct sunlight generally exhibited better growth than those grown under shaded conditions.

In contrast, plants exposed to low light intensity (L5) displayed reduced fresh and dry weights, consistent with the findings of Wilson and Coope (1969), who observed that reduced light exposure negatively affected leaf area and plant development. The negative impact of low light intensity on plant growth in this study underscores the importance of adequate light for photosynthesis, a process that is vital for the plant's energy production and biomass

accumulation. As expected, plants in low light conditions were shorter and had smaller leaves, similar to reports by Grabau *et al.* (1990), where light reduction was shown to decrease the rate of photosynthesis, thereby limiting plant growth.

Interestingly, the results for chlorophyll content in this study revealed an unexpected pattern. While plants exposed to high light intensity (H4) generally had lower chlorophyll content than those exposed to medium (M5) and low light intensity (L5), this is in line with known adaptive mechanisms in plants. Under low light conditions, *Zea mays* plants tend to increase chlorophyll production to maximize light absorption, as reported by Baiyeri (2006). This adaptive response allows the plant to capture more light energy to drive photosynthesis, albeit with reduced growth overall. The findings support the hypothesis that chlorophyll content may not always correlate directly with plant size or biomass, as chlorophyll production can be adjusted in response to light availability, but does not fully compensate for the overall limitations imposed by insufficient light.

The increase in leaf number, plant height, and leaf area under high light intensity (H4) further substantiates the role of light in enhancing plant growth. Plants under H4 showed greater leaf numbers, taller heights, and larger leaf areas, all of which contribute to improved photosynthesis. Larger leaves provide a greater surface area for light absorption, and taller plants allow for better competition for light, particularly in dense planting conditions. These findings are in agreement with studies that have shown that high light intensity promotes cell elongation and leaf expansion, leading to improved photosynthetic efficiency (Lambers *et al.*, 2008). Conversely, low light conditions (L5) led to stunted growth, with reduced leaf area and fewer leaves, which significantly impacts photosynthetic capacity.

It is worth noting that the plants in the high light intensity group (H4) were able to achieve optimal growth, likely due to the enhanced photosynthesis facilitated by greater light availability. The high light intensity treatment provided the necessary energy for the plant's metabolic processes, leading to robust growth and strong biomass accumulation. On the other hand, plants in low light conditions exhibited compensatory mechanisms, such as an increase in chlorophyll content, to maximize light absorption, but this did not fully mitigate the growth limitations imposed by the reduced light availability. This is similar to the findings of Fujita *et al.* (1993) and Wong (1991), who reported that shading negatively affected growth and yield in tropical crops, including legumes and other understory plants in agroforestry systems.

Conversely, low light intensity (L5) resulted in reduced root biomass, indicating a diversion of limited resources toward survival rather than growth. The stunted root systems in L5 highlight the dependence of root development on photosynthetic efficiency and energy availability. These findings align with studies that emphasize the interdependence of root and shoot development, where a well-developed root system supports better shoot growth through efficient resource acquisition.

The findings of this study provide strong evidence that light intensity plays a critical role in the growth and development of *Zea mays*. High light intensity promotes superior growth in terms of fresh weight, dry weight, leaf number, plant height, and leaf area, all of which are crucial for overall plant productivity. On the other hand, low light intensity results in reduced growth but triggers an increase in chlorophyll content as an adaptive response. These results underscore the importance of light as a key factor in determining the growth and yield of *Zea mays*, and provide valuable insights for optimizing growing conditions in agricultural and horticultural practices.

## **CONCLUSION**

The study confirms that light intensity plays a crucial role in the growth of *Zea mays*. High light intensity promotes better biomass accumulation, higher leaf number, and increased plant height compared to lower light conditions.

## **RECOMMNDATION**

To achieve optimal growth and yield in *Zea mays*, it is recommended that plants receive high light intensity, especially during key growth phases. Shading should be minimized to avoid stunted growth.

## REFERENCES

- Akintoye, H. A., Adeoye, G. O. and Fatoba, P. O. (2011). Effect of fertilizers on growth and yield of maize in Nigeria. *World Journal of Agricultural Sciences*, **7**(2): 231 – 239.
- Akintoye, O., Adewale, A. and Olatunji, S. (2011). Plant physiology: An introduction. *Nigerian Journal of Agriculture*, **8**(3): 45 – 56.
- Alvarez, R. and Martinez, S. (1992). Light and plant mortality: A study on environmental stress. *Botany Review*, **18**(4): 210 – 219.
- Baiyeri, K. P. (2006). Variation in plant response to different light intensities in tropical crop species. *Agronomy Journal*, **14**(3): 245 – 258.
- Banerjee, P., Singh, R. and Gupta, A. (2007). Photo-inhibition and growth limitations in plants. *Journal of Plant Sciences*, **5**(6): 301 – 308.
- Beadle, G. W. (1937). The photosynthetic adaptation of *Zea mays* in different environments. *Journal of Plant Physiology*, **21**(1): 12 – 21.
- Bennett, S. (2010). Plants and human survival. *Agriculture and Ecology Journal*, **15**(2): 78 – 85.
- Bjorkman, O. and Holmgren, P. (1963). Sun and shade leaves: Variations in photosynthetic activity. *Plant Ecology Research*, **9**(4): 365 – 370.
- Bouis, H. E., Meenakshi, J. V. and Welch, R. M. (2011). The economic and social impact of maize in Sub-Saharan Africa. *Food Security*, **3**(4): 349 – 358.
- Darko, E., Bakos, F. and Ferenc, T. (2014). The role of photomorphogenesis in *Zea mays* development. *Photosynthesis Research Journal*, **32**(7): 510 – 518.

- Darko, E., Heydarizadeh, P. and Schoefs, B. (2014). Photosynthesis under artificial light: The shift in primary and secondary metabolism. *Frontiers in Plant Science*, **5**: 1 – 13.
- Dowswell, C. R. and Paliwal, R. L. (1996). Maize in the developing world. *Food Crop Research Institute Journal*, **42**(5): 78 – 85.
- Eze, C. (1965). Graph-based method for leaf area determination. *Nigerian Journal of Botany*, **3**(2): 56 – 60.
- Fageria, N. K., Baligar, V. C. and Clark, R. B. (2011). Physiology of crop production. *Agricultural Science Journal*, **4**(6): 120 – 145.
- Fageria, N. K., Baligar, V. C. and Clark, R. B. (2011). Physiology of crop production. *Springer Science and Business Media*, **1**, 1 – 23.
- FAO. (2021). Food and Agriculture Organization: Maize production statistics.
- Flint-Garcia, S. A., McMullen, M. D. and Darrah, L. L. (2009). Genetics of maize resistance to pests and diseases: Implications for breeding. *Crop Science*, **49**(2): 402 – 411.
- Fujita, M. and Yasumoto, H. (1993). The effects of shading on biomass production. *Crop Science*, **34**(4), 72 – 77.
- Grabau, C., Henry, P. and Okezie, O. (1990). Light intensity and photosynthesis: Effects on plant growth and development. *Photosynthesis Research Journal*, **12**(2): 189 – 200.
- Kassie, M., Jaleta, M., Shiferaw, B., Mmbando, F. and Mekuria, M. (2015). Improving maize productivity in developing countries: A review of the challenges and opportunities. *Agricultural Systems*, **137**, 120 – 132.

- Klein, R. M. (1992). Photosynthesis: Principles and applications in agriculture. *Agriculture Research Journal*, **19**(3), 210 – 222.
- Lambers, H., Chapin, F. S. and Pons, T. L. (2008). Plant physiological responses to light intensity. *Plant Biology*, **27**(5): 432 – 445.
- Leung, H., Takashi, K. and Akira, N. (1968). Antioxidant properties of plants in low light environments. *Journal of Plant Nutritional Studies*, **13**(1): 22 – 35.
- Li, J., Wang, C. and Chen, Z. (2022). High light intensity enhances maize grain yield and photosynthetic activity. *Field Crops Research*, **276**: 108 – 548.
- Liska, A. J., Yang, H. S., Bremer, V. R., Klopfenstein, T. J., Walters, D. T., Galen, E. and Cassman, K. G. (2014). Maize-based ethanol and its implications for U.S. energy policy. *Environmental Research Letters*, **9**(12): 124 – 210.
- Liu, Y., Huang, X., and Shen, Y. (2020). Photoinhibition effects on maize under extreme light conditions. *Journal of Experimental Botany*, **71**(10): 3021 – 3031.
- Mangelsdorf, P. C. (1974). The origin and evolution of maize. *American Journal of Botany*, **61**(1): 1 – 8.
- Marshall, D. (2004). Introduction to plant biology. *Journal of Natural Sciences*, **12**(6): 85 – 90.
- Mayer, A. M. and Mayber, A. (1982). Light effects on stem elongation and photosynthesis. *Botanical Studies*, **8**(3): 45 – 58.
- Moser, R., Fischer, R. A. and Brown, P. (2021). Adapting maize cultivation to climate change: The role of hybrid varieties. *Climate Change and Agriculture*, **24**(2): 123 – 132.

- Ologundudu, E. A., Adeleye, S. A., and Alade, F. (2013). Growth responses of *Zea mays* and other species to varying light regimes. *International Journal of Horticultural Science*, **20**(5): 241 – 248.
- light stress on germination and growth of *Zea mays* and other crop species. *Nigerian Agricultural Journal*, *44*(1), 77–86.
- Osunkoya, O. O., & Omar, A. M. (1994). Reduced light intensity and crop performance. *Tropical Agriculture Journal*, *11*(2), 36–48.
- Razzak, M. (2017). Photosynthetic and growth dynamics in maize under light variations. *Journal of Plant Physiology*, *29*(9), 101–116.
- Razzak, M. A. (2017). Photosynthetic efficiency and maize production: Exploring environmental interactions. *Agronomy Journal*, *109*(2), 341–349.
- Sheahan, M., & Barrett, C. B. (2017). Food insecurity in Sub-Saharan Africa and Latin America: The role of maize. *Agricultural Economics*, *48*(3), 455–465.
- Singh, R., Gupta, A., & Banerjee, P. (2022). The effect of light intensity on seedling growth and germination rates of maize. *Plant Physiology Journal*, *54*(7), 1210–1217.
- Wilson, J. P., & Coope, D. A. (1969). Effects of light intensity on leaf growth and photosynthesis. *Botany Journal*, *36*(4), 512–524.
- Zhang, H., Liu, B., & Wang, J. (2023). The impact of light intensity on photosynthesis and dry matter production in maize plants. *Photosynthesis Research*, *138*(2), 435–444.
- Zhu, X. G., Long, S. P., & Ort, D. R. (2014). The biochemical basis of photosynthesis in *Zea mays*. *Plant Science Journal*, *41*(6), 78–88.