GERMINATION OF COMMON BEANS (*Phaseolus vulgaris*) USING GROWTH REGULATORS SODIUM NITROPRUSSIDE (SNP), INODLE-3-ACETIC ACID (IAA) AND VITAMIN C

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DEPARTMENT OF SCIENCE LABORATORY TECHNOLOGY

(BIOTECHNOLOGY TECHNIQUES)

FACULTY OF LIFE SCIENCES UNIVERSITY

OF BENIN,

BENIN CITY.

OCTOBER 2025.

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A PROJECT WORK SUBMITTED TO THE DEPARTMENT OF SCIENCE LABORATORY TECHNOLOGY, FACULTY OF LIFE SCIENCES, UNIVERSITY OF BENIN. BENIN CITY, EDO STATE, NIGERIA, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR DEGREE (BSc.) IN SCIENCE LABORATORY TECHNOLOGY (BIOTECHNOLOGICAL TECHNIQUES)

OCTOBER, 2025

CERTIFICATION

This is to certify that this project work, titled "**PROXIMATE ANALYSIS OF BEANS *(Phaseolus vulgaris*) USING GROWTH REGULATORS SODIUM NITROPUSSIDE**

(SNP), INDOLE -3- ACETIC ACID (IAA) and VITAMIN C" was carried out by Ifeakachukwu Princess Akpati with matriculation number LSC2007269 of the Department of Science Laboratory Technology (Biotechnology Techniques), Faculty of Life Sciences, University of Benin City, Edo State, under the supervision of DR Alex Orupke

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STUDENT'S THESIS

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DEDICATION

I dedicate this project work to God Almighty, my family and friends and Supervisor who have shown constant support and encouragement throughout this journey.

ACKNOWLEGEMENT

First and foremost, I give thanks to Almighty God for His endless grace, wisdom and strength that enabled me to complete this seminar work successfully.

I would also like to extend my heartfelt gratitude to my supervisor, DR Alex Orukpe for his guidance, support and constructive feedback throughout this seminar work. His mentorship and knowledge greatly contributed quality and successful completion of this seminar work.

I would like to specially appreciate my parents, Mr. Akpati Ikechukuwu and late Mrs. Akpati Chinelo or their unending prayers and support throughout this seminar work.

I would also like to appreciate my Lovely elder Sister Akpati Ogechukwu Amanda for being my biggest supporter and advisor during this project work.

I also sincerely and specially appreciate my Friend IDAHOSA Solomon Osahon and ERAHVICTOR Ebosetale for his their words of encouragement and endless support throughout this project work.

I also want to acknowledge my siblings and friends for their motivation, understanding and unwavering support throughout my academic journey.

Lastly, I want to acknowledge my BTT family for their constant encouragement and support.

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ABSTRACT

Common beans (*Phaseolus vulgaris* L.) are a vital food crop in Nigeria, valued for their rich protein content and contribution to food security. However, challenges in seed germination and early seedling establishment often limit productivity. This study examined the effects of three growth regulators Indole-3-Acetic Acid (IAA), Sodium Nitroprusside (SNP), and Vitamin C (Vit C) on the germination, early growth, and field performance of brown and white bean varieties. Seeds were primed with 100, 500, and 1000 ppm concentrations of each regulator, germinated on cotton wool, and later transplanted to nursery and field conditions. Parameters such as germination rate, shoot and root length, root number, biomass, and moisture content were evaluated. Results showed that SNP treatments produced the best overall growth, significantly enhancing germination rate, shoot elongation, and field performance. Vitamin C improved vegetative growth and seedling vigor, while high concentrations of IAA negatively affected germination and early development. The study concludes that moderate SNP concentrations can effectively promote seedling establishment and growth, and recommends further research on long-term yield impacts and varietal responses. These findings provide insight into optimizing bean production through the targeted use of plant growth regulators

CHAPTER ONE

INTRODUCTION

The common bean (*Phaseolus vulgaris* L.) is among the most vital food crops globally, providing an excellent source of plant-based protein for millions of people. It holds particular importance in regions such as Latin America, sub-Saharan Africa, and parts of Asia, where it serves as a dietary staple. Beans are highly nutritious, containing essential amino acids like lysine and tryptophan, as well as dietary fiber, complex carbohydrates, vitamins, and vital minerals such as iron and zinc. In Nigeria, the common bean is not only a major food item but also a crucial and affordable source of protein. It contributes significantly to food security and plays a key role in supporting the livelihoods of rural farmers and their communities (FAO, 2024; Blair et al., 2010).

A straightforward method to assess the nutritional quality of a food crop involves analyzing factors such as its moisture, protein, fat, fiber, ash content after burning, and carbohydrate levels. Although the nutrient composition of common beans has been widely documented, increasing attention is now being paid to how agricultural practices such as seed treatment with plant growth substances can affect the nutritional value of the harvested beans. Factors including the plant variety, color of the seed coat, environmental conditions, and pre-planting treatments are known to significantly influence the nutrient profile of legume seeds.

Plant growth substances are chemical compounds that modify how plants respond to both internal and external stimuli. These substances whether naturally occurring or synthetic included, compounds like Indole-3-acetic acid (IAA), ascorbic acid (Vitamin C), and sodium nitroprusside (SNP), which releases nitric oxide. Research has shown that such substances can enhance seed germination, strengthen seedlings, improve plant stress tolerance, and boost overall plant performance (Davies, 2010; Smirnoff, 2000; Muratović et al.).

2017). Past studies have looked at how these substances affect how well legumes grow (Audi and amp; Muhktar, 2009; Nadeem *et al.*, 2021) and how seeds sprout (Singh *et al.*, 2014; Ali and amp; El-Karkouri, 2018), but not many have checked to see if they can change how nutritious the mature seeds are.

So, this study will examine how different amounts of IAA, SNP, and Vitamin C affect what's in brown and white common bean seeds. By seeing how these seeds react to the plant growth substance treatments, the study wants to add new information about how using these

substances can improve how nutritious beans are. The results will also help with managing seeds and help efforts to improve the nutritional value of legumes in farming systems with limited resources, like those in Nigeria.

Plate 1.1: Image showing white and Brown common bean (Phaseolus vulgaris L.) seeds.

1.1 BACKGROUND OF STUDY

The common bean (*Phaseolus vulgaris* L.) is one of the most important legumes in global agriculture and serves as a staple food in Nigeria. It features prominently in popular local meals such as *moi moi*, *akara*, and *ewa*. Beyond its culinary use, this crop is essential for strengthening household food security, enhancing rural nutrition, and generating income for smallholder farmers (Ugwu and Okoro, 2021). Nigeria ranks among Africa's top producers and consumers of common beans, with an annual production estimated at about 1.3 million metric tons most of which comes from northern states like Kano, Kaduna, and Katsina (Nwokocha et al., 2019; FAO, 2024a). Despite its nutritional importance and economic value, bean cultivation in Nigeria faces several agronomic challenges, with poor and irregular seed germination standing out as a major limitation.

Germination represents a crucial stage in the life cycle of plants, significantly influencing seedling establishment, plant vigor, and final yield. Numerous internal and external factors can affect the success of germination in common beans. For example, characteristics such as seed coat thickness and permeability, temperature, moisture availability, and the internal hormonal balance all play critical roles (Sano et al., 2016). In addition, environmental stresses like drought, extreme temperature fluctuations, and poor soil fertility can hinder germination and early seedling development, ultimately reducing crop performance and nutrient absorption (Aouani et al., 1998).

In the past, most studies on common beans have focused mainly on improving yield potential and developing disease-resistant varieties. Recently, however, more attention has been directed toward enhancing the nutritional value of the seeds, particularly through the study of their proximate composition. The proximate composition refers to the major nutritional components of the seed such as crude protein, crude fat, moisture, ash, crude fiber, and carbohydrates. These elements are vital for determining the food quality and dietary importance of beans. Their composition can be influenced by genetic traits, physiological processes, environmental conditions, and the vigor or quality of seeds used for cultivation (Broughton et al., 2003; Blair et al., 2010).

To tackle challenges with germination and possibly boost seed quality, researchers have really started using seed priming techniques along with plant growth regulators (PGRs) in legume studies. PGRs like Indole-3-acetic acid (IAA), Ascorbic acid (Vitamin C), and Sodium nitroprusside (SNP) have shown promise in helping with early germination, establishing seedlings, and dealing with stress (Singh *et al.*, 2021; Khatri *et al.*, 2017; Muratović *et al.*, 2017). For instance, in common beans, using IAA before planting has been found to promote cell division and root growth. As for ascorbic acid, it plays a role in antioxidant protection and enhancing the plant's ability to handle stress (Souri and Hatamian, 2019). Sodium nitroprusside, which donates nitric oxide, helps adjust various physiological responses and metabolic pathways, impacting plant growth and adaptability when conditions aren't ideal (Fan *et al.*, 2022).

Common beans are valued not just for their ability to grow in diverse conditions, but also for the nutrition they provide. While plant growth regulators (PGRs) have been widely studied in beans for their role in growth and stress tolerance, little attention has been given to how these treatments might influence the actual nutritional quality of the seeds we eat. Even more, the differences between seed colors like white and brown beans are often overlooked, even though they may respond differently to priming treatments. This research sets out to close that gap by examining how seed priming with IAA, SNP, and Vitamin C affects the nutritional makeup of two common bean varieties grown in Nigeria. By focusing on key nutrients such as protein, fat, fiber, ash, moisture, and carbohydrate content, the study hopes to show whether early interventions during germination can lead to meaningful improvements at harvest. Ultimately, the findings could offer farmers and communities practical strategies for producing beans that are not only resilient in the field but also richer in nutrition, supporting efforts toward food and nutritional security in Nigeria.

1.2 STATEMENT OF THE PROBLEM

Even though the common bean (Phaseolus vulgaris L.) has a lot of advantages and plays a crucial role in in the diet of many Nigerians,, its productivity often suffers due to poor seed germination. When germination is uneven or delayed, it leads to inconsistent plant growth, inefficient use of resources, and ultimately lower yields. Seed priming and using growth regulators seem to help with germination and early growth, but we lack enough data to compare how these methods work on different types of cowpea seeds, like white and brown. This knowledge gap makes it tough to suggest effective strategies for improving germination for farmers and seed producers. Specifically, we still don’t know much about how white and brown bean seeds respond to different amounts of IAA, ascorbic acid, and sodium nitroprusside, particularly in relation to their proximate composition. This lack of understanding is a barrier to creating tailored and effective seed treatment methods that could boost common bean production in various farming environments.

1.3 AIM OF STUDY

Germination of Common Beans (*phaseolus vulgaris*) using growth regulators Sodium Nitropusside (SNP), inodle-3-acetic acid (IAA) and Vitamin C. The Aim in this study is to compare the effects of Different plant growth regulators in directly compare how different plant

growth regulators specifically Indole-3-acetic acid, Vitamin C, and Sodium nitroprusside impact the Germination and Growth of white and brown common bean

(*Phaseolus vulgaris* L.) seeds

1.4 OBJECTIVES OF STUDY

To achieve this aim, the study is guided by the following specific objectives:

1. To determine the effects of varying concentrations of Indole-3-Acetic Acid (IAA), Vitamin C, and Sodium Nitroprusside (SNP) on the germination rate of white and brown common bean seeds.
2. To evaluate the influence of these growth regulators on early growth parameters such as shoot length, root length, root number, biomass, and moisture content.
3. To compare the germination and early growth responses of white and brown common bean varieties treated with different concentrations of the growth regulators.
4. To identify the most effective growth regulator and concentration that enhances germination and promotes healthy early growth in common beans.

1.5 DEFINITION OF TERMS

To keep us all on the same page, here are the key terms we'll be using, explained in simple terms:

- **Common Bean (*Phaseolus vulgaris* L.):** This is a widely grown legume in warm and mild climates around the globe, cherished for its edible seeds that are packed with protein.

    - Kingdom: Plantae
    - Division: Magnoliophyta (Flowering plants)
    - Class: Magnoliopsida (Dicotyledons)
    - Order: Fabales
    - Family: Fabaceae (Leguminosae)
    - Subfamily: Papilionoideae (Faboideae)
    - Genus: *Phaseolus*
    - Species: *Phaseolus vulgaris* L.

    Plant Growth Regulators (PGRs): Think of these as tiny chemical signals, either made by the plant itself or given to it. Even in super small amounts, they can either speed up, slow down, or otherwise tweak how a plant grows and develops, potentially influencing its nutrient accumulation.

- **Indole-3-acetic acid (IAA):** This is a natural **auxin**, a vital plant hormone. It's like a master builder, directing cells to stretch, divide, and specialize, which is crucial for overall plant growth and development.

- **Vitamin C:** A powerful natural **antioxidant** found in plants. It's the plant's shield, protecting its cells from stress and helping to keep its metabolic processes running smoothly, which could impact nutrient synthesis.
- **Sodium Nitroprusside (SNP):** This is a compound that releases **nitric oxide (NO)**, a crucial signaling molecule in plants. It's involved in all sorts of plant processes, including stress responses and metabolic adjustments.

- **Seed Priming:** Imagine giving a seed a controlled sip of water before planting. This special pre-treatment lets the seed start its internal engines without actually sprouting, influencing early metabolic pathways that could affect later nutrient development..
- **Moisture Content:** The amount of water present in a food sample, usually expressed as a percentage of the total weight.
- **Seed Priming:** A pre-sowing seed treatment involving controlled hydration that allows metabolic processes to begin without radical emergence, often leading to faster and more uniform germination when planted.
- **Dormancy:** A state in which seeds are prevented from germinating even under environmental conditions normally favorable for germination.

1.6 SIGNIFICANCE OF THE STUDY

This research carries significant implications beyond the laboratory, offering practical value to multiple stakeholders across Nigeria's agricultural and public health sectors. For farmers, the study provides insights into how seed priming with plant growth regulators can not only improve germination but also enhance the nutritional value of their harvests, potentially increasing market value and household dietary quality. Food processors and consumers stand to benefit through the development and access to more nutrient-dense bean-based products, helping to address malnutrition. Seed producers and agricultural extension workers will gain actionable knowledge to support the development and dissemination of optimized priming protocols tailored to different bean varieties. Academically, the study fills a critical gap by exploring how IAA, ascorbic acid, and SNP affect proximate composition, contributing to a deeper understanding of seed physiology and supporting future biofortification research. Moreover, by promoting nutrient-rich common beans, the study supports food security policies and enhances the nutritional landscape for vulnerable populations. Ultimately, boosting the nutritional profile of such a widely consumed staple also strengthens Nigeria's agricultural economy by improving crop quality and smallholder farmer livelihood.

1.7 SCOPE AND LIMITATIONS OF THE STUDY

This study focuses on the nutritional qualities of two types of beans that many Nigerians rely on for food and a source of protein, the white and brown common bean. Seeds were first primed with three growth regulators (Indole-3-acetic acid, Sodium Nitroprusside, and Ascorbic Acid) and allowed to germinate for 120 hours under laboratory conditions. After this early stage, the seedlings were transplanted into a nursery and later into the field, where they were observed for three months to see how these treatments influenced their growth and nutritional composition. The analysis centers on proximate components such as protein, fat, fiber, moisture, ash, and digestible carbohydrates.

Even though this work covers both controlled and field conditions, it still has its limits. Environmental factors like soil variability, pest pressure, and changing climate were present in the field but not studied in depth, which may affect how broadly the findings can be applied. Only two bean varieties were tested, so results may not reflect the diversity of cultivars grown across Nigeria. The study is also limited to three growth regulators at specific concentrations, leaving out other possible regulators or dosage levels. Additionally, the research examines only proximate nutritional traits. It does not include micronutrients, anti-nutritional compounds, or sensory qualities such as taste. Finally, while the study observes nutritional changes over three months, it does not explore the underlying biochemical or genetic mechanisms behind these outcomes, focusing instead on the measurable nutritional results.

CHAPTER TWO

LITERATURE REVIEW

2.1. INTRODUCTION

Common beans (Phaseolus vulgaris L.), including both the brown and white varieties, are among the key grain legumes grown and eaten in sub-Saharan Africa, particularly in Nigeria. People really value these beans for their ability to thrive in various agricultural settings, as well as for their nutritional and economic benefits, especially in less developed communities. Both types of beans provide a great source of high-quality plant protein and are especially high in lysine and tryptophan, essential amino acids that complement the cereal-heavy diets typical in West Africa (Broughton *et al.*, 2003). Plus, they're packed with essential micronutrients like iron, zinc, folate, magnesium, and dietary fiber, which play a significant role in reducing micronutrient deficiencies (Blair *et al.*, 2010; Bouis and Welch, 2010).

In Nigeria, you'll find that common beans are a staple in many homes, and they're used to whip up popular dishes like akara, moi-moi, ewa riro, and beans porridge. People often lean towards brown beans because of their unique flavor and the nice color they hold after cooking. White beans, on the other hand, are usually the go-to for making moi moi, which tends to have a softer texture. According to FAOSTAT (2020), Nigeria stands out as one of the top producers of common beans in Africa, churning out over 1.3 million metric tonnes every year, with smallholder farmers in Katsina, Kaduna, and Kano playing a key role in this production.

Other than nutrition, common beans (*Phaseolus vulgaris* L.), can also offer ecological benefits through biological nitrogen fixation, which improves soil fertility and reducing the need for synthetic fertilizers (Beebe *et al.,* 2013). But, their productivity and seedling establishment are significantly influenced by both environmental (e.g., drought, salinity, temperature) and internal physiological factors (e.g., seed viability, dormancy, and seed coat structure) and Understanding how these factors affect the germination of brown and white beans is essential for improving crop performance, especially under stress-prone conditions common in many parts of Nigeria and tropical Africa (Katungi *et al.*, 2009; Ouma *et al.*, 2021).

2.1.2 THE IMPORTANCE AND BIOLOGY OF COMMON BEANS (PHASEOLUS VULGARIS L.)

Common beans (*Phaseolus vulgaris* L.), including the brown-seeded variety, are one of the most significant grain legumes globally and serve as a vital **staple crop** in many regions of sub-Saharan Africa, Latin America, and parts of Asia (Broughton *et al.*, 2003). In Nigeria, brown beans are very important because of their widespread consumption and high nutritional value. It also contributes to household food security. It is often referred to as the "poor man's meat," they are a rich source of plant-based protein, essential amino acids (like lysine and tryptophan), dietary fiber, and key micronutrients such as iron, zinc, magnesium, and folate (Blair *et al.*, 2010; Bouis and Welch, 2010).

Brown beans also support income generation for smaller farmers in developing communities, as they are in high demand across local markets. (Beebe *et al.*, 2013). Furthermore, through biological nitrogen fixation, common beans improve soil fertility and reduce the need for chemical fertilizers, enhancing sustainability in crop production systems (Graham *and* Vance, 2003).

Biologically, *P. vulgaris* is an annual crop that has a relatively quick growth cycle (60–90 days), which allows for **multiple harvesting seasons** in in a year especially in tropical regions.
It is genetically diverse, especially among African countries, offers potential for developing stress-tolerant and high-yielding cultivars adapted to local environmental conditions (Katungi *et al.*, 2009).

2.1.4 NUTRITIONAL PROFILE OF BROWN AND WHITE BEANS (PHASEOLUS VULGARIS L.)

Common beans (*Phaseolus vulgaris* L.), including both brown and white varieties, are highly nutritious legumes that serve as an essential source of plant protein across sub-Saharan Africa, Latin America, and Asia. On average, common bean seeds contain 20–25% protein, making them a valuable source of plant-based protein which surpasses most cereals in terms of protein quality (Broughton *et al.*, 2003). They are particularly rich in essential amino acids such as lysine and tryptophan, which are often deficient in staple grains like maize, rice, and sorghum (Blair *et al.*, 2010). These amino acids are critical for human growth, tissue repair, and immune function.

Other than to serving as a rich source of protein, it has a contains significant amounts of dietary fiber, complex carbohydrates, and essential micronutrients such as iron, zinc, folate, magnesium, and B vitamins (Petry *et al.*, 2015; Bouis *and* Welch, 2010). The fiber content is beneficial for gastrointestinal health and aids in the regulation of blood sugar levels. Furthermore, folate is vital for DNA synthesis and the formation of red blood cells, making it especially important during pregnancy to mitigate the risk of birth defects in Fetus. Even though the core nutritional composition ibetween brown and white bean varieties is similar , some differences exist. For example Brown beans typically have higher levels of phenolic compounds and tannins concentrated in their seed coats, which not only give them their characteristic color but may also provide antioxidant and antimicrobial benefits (Akond *et al.*, 2011). These compounds may enhance shelf life and health-promoting properties, though in excess, they can slightly reduce mineral bioavailability by binding with iron or zinc. While white beans pigmented seed coats, because of lower tannin levels, potentially allowing for better mineral absorption and faster cooking times. Their smoother texture and neutral color make them more suitable for certain types of foods such as baby foods, purees, or blended meals (Oluseyi *et al.*, 2023). However, both varieties retain high nutritional value and are important dietary staples that contribute significantly to protein-energy balance, especially in resource-limited settings.

2.2 SEED GERMINATION: MECHANISMS AND INFLUENCING FACTORS

Seed germination is a multifaceted physiological process that initiates with the activation of metabolic pathways and culminates in the emergence of the radicle. It signifies the transition of the seed from dormancy to active growth, serving as a crucial determinant of crop establishment and yield potential (Lamichhane *et al.*, 2022)

2.2.1 PHASES OF GERMINATION

Germination typically goes through three phases and they are: (Bewley *et al.*, 2013):

- **Phase I (Imbibition Phase):** This initial rapid uptake of water by the dry seed is purely physical, driven by the water potential gradient between the seed and its environment. During this phase, the seed swells, and its metabolic machinery begins to rehydrate.

- **Phase II (Lag Phase/Metabolic Activation Phase):** Following imbibition, water uptake slows or plateaus. This phase is characterized by intense metabolic activity. Stored food reserves (proteins, lipids, carbohydrates) are mobilized and broken down by activated enzymes (e.g., amylases, proteases, lipases) to provide energy and building blocks for growth. DNA repair, RNA synthesis, and protein synthesis also occur, preparing the embryo for radical protrusion.

- **Phase III (Radical Protrusion Phase):** This phase marks the completion of germination, and is characterized by a renewed, rapid uptake of water and the irreversible elongation of the radical which is the Embryonic root that, breaks through the seed coat. This growth is primarily due to cell expansion rather than cell division at this very early stage.

2.2.2 Factors Affecting Common Bean (*Phaseolus vulgaris* L.) Seed Germination

The germination of common bean seeds depends on a combination of environmental conditions and internal physiological factors that determine how successfully a seed transforms into a healthy seedling. Some of the key influences include water, temperature, oxygen, light, the nature of the seed coat, dormancy status, and genetic makeup.

1. Water Availability

Water is the first and most critical ingredient needed for germination to begin. It activates enzymes and kick-starts the seed's metabolism through a process called imbibition – when the seed absorbs water and swells. But the balance needs to be correct. While too much water (flooding or waterlogging) restricts oxygen supply and inhibits growth, too little water (drought) stops the seed from initiating this process. Seeds cannot adequately absorb water in saline or dry conditions, which results in delayed germination and weaker seedlings (Aouani et al., 1998; Singh and Munoz, 1999). Limited moisture is still one of the key obstacles to good bean germination in many arid parts of Africa (Maingi et al., 2001).

2. Temperature

Temperature strongly affects the speed and uniformity of germination. Optimal germination of common bean typically occurs between 20°C and 30°C. High temperatures (>35°C) may lead to heat stress, damaging cellular structures and proteins, while low temperatures can slow down metabolic rates and delay germination (Blair *et al.*, 2010). Singh and Munoz (1999) also report that temperature extremes impact both the germination percentage and seedling vigor.

3. Oxygen Availability

Adequate oxygen is crucial during Phase II of germination when aerobic respiration begins. Waterlogged or compacted soils reduce oxygen diffusion, forcing the seed to rely on anaerobic respiration, which is less efficient and can generate toxic by-products (St. Clair *et al.*, 2005). Such hypoxic conditions have been shown to significantly reduce common bean seedling emergence and biomass accumulation.

4. Light

Although most common bean varieties are considered photoblastic-neutral (not dependent on light for germination), extreme exposure to strong or direct light can affect seedling morphology and development in some genotypes (Wortmann, 1993). However, for the majority of common bean varieties, light does not play a significant role in the initiation of germination.

5. Seed Coat Characteristics

The physical structure and chemical properties of the seed coat significantly influence water permeability and gas exchange. In common bean, seed coat impermeability (hard seed trait) can cause delayed germination or complete dormancy. This dormancy is primarily due to a lignified palisade layer that prevents imbibition (Beaver *and* Rosas, 1994; Bello *et al.*, 2021). Variability in seed coat hardness has been linked to genetic differences and environmental conditions during seed development (Tully *et al.*, 1981).

6. Seed Dormancy

Although common bean generally exhibits low to moderate dormancy compared to other legumes, some genotypes, particularly wild types or those bred for drought tolerance, retain dormancy due to seed coat impermeability or hormonal imbalances (Bello *et al.*, 2021). Dormancy can be beneficial for avoiding germination under transiently favorable conditions but is problematic for cultivation requiring uniform emergence (Beaver *and* Rosas, 1994).

7. Seed Viability and Vigor

The inherent physiological state of the seeds, its moisture content, enzymatic activity, and energy reserves determines its ability to germinate successfully. Seed aging, poor storage, or exposure to abiotic stress can reduce viability. Blair *et al.* (2010) emphasized that genotypic differences also account for significant variability in seedling vigor and germination rate.

2.3 PLANT GROWTH REGULATORS (PGRS) AND THEIR ROLE IN GERMINATION

Plant growth regulators (PGRs) are organic compounds, other than nutrients, that in small amounts promote, inhibit, or otherwise modify any physiological process in plants (Davies, 2010). They play crucial roles in regulating plant growth and development, including seed germination, seedling establishment, root development, flowering, and fruit ripening. The strategic application of exogenous PGRs can manipulate these processes to enhance crop productivity

2.3.1 INDOLE-3-ACETIC ACID (IAA) AND AUXINS

Auxins are a class of plant hormones that are fundamental to plant growth and development. Indole-3-acetic acid (IAA) is the most abundant and physiologically active naturally occurring auxin (Teale *et al.*, 2006). Auxins are primarily synthesized in apical meristems (shoot tips, young leaves) and transported throughout the plant, influencing a wide range of processes, including cell elongation, cell division, differentiation of vascular tissues, and root initiation.

In the context of seed germination, IAA plays several critical roles:

- **Cell Elongation:** Auxins promote the elongation of cells, particularly in the radical, which is essential for its protrusion through the seed coat (Davies, 2010).
- **Enzyme Activity:** IAA can influence the activity of various enzymes involved in the breakdown of stored food reserves (e.g., amylases, proteases), thereby facilitating the mobilization of nutrients for the growing embryo (Kucera *et al.*, 2005).
- **Root Development:** Exogenous application of IAA can stimulate the development of a robust root system, which is vital for water and nutrient uptake by the young seedling (Audi *and* Muhktar, 2009).

- **Interaction with other hormones:** IAA interacts synergistically or antagonistically with other plant hormones, such as gibberellins (which promote germination) and abscisic acid (which promotes dormancy), to regulate the overall germination process (Kucera *et al.*, 2005).

2.3.2 VITAMIN C AS A GROWTH REGULATOR

Ascorbic acid (Vitamin C) is a ubiquitous antioxidant in plants, playing a multifaceted role beyond its nutritional value to humans. It is involved in various physiological processes, including photosynthesis, cell wall synthesis, and stress tolerance (Smirnoff *and* Wheeler, 2000). While not traditionally classified as a classical plant hormone, its regulatory effects on plant growth and development, particularly under stress, justify its consideration as a growth regulator.

In relation to seed germination, Vitamin C contributes by:

- **Antioxidant Defense:** Germination is an oxidative process that can generate reactive oxygen species (ROS), which can damage cellular components. Ascorbic acid acts as a potent antioxidant, scavenging ROS and protecting seed tissues from oxidative damage, thereby enhancing seed viability and vigor (Nunes *et al.*, 2020).
- **Metabolic Regulation:** It can influence the activity of enzymes involved in metabolic pathways crucial for germination, such as those related to carbohydrate metabolism (Smirnoff *and* Wheeler, 2000).
- **Stress Alleviation:** Under adverse conditions like drought or salinity, Vitamin C priming can improve germination rates by enhancing the seed's physiological resilience and mitigating the negative impacts of stress (Nunes *et al.*, 2020).

2.3.3 SODIUM NITROPRUSSIDE (SNP) AND NITRIC OXIDE

Sodium nitroprusside (SNP) is a compound commonly used as an exogenous donor of nitric oxide (NO) in plant studies. Nitric oxide is a gaseous signaling molecule that plays diverse roles in plant physiology, including growth, development, and responses to abiotic and biotic stresses (Mur *et al.*, 2013).

The role of NO, delivered via SNP, in seed germination is gaining increasing recognition:

- **Dormancy Breaking:** NO has been shown to effectively break various types of seed dormancy, including physiological dormancy, by interacting with abscisic acid (ABA) signaling pathways and promoting the synthesis of germination-promoting hormones like gibberellins (Arc *et al.*, 2011).
- **Enzyme Activation:** NO can modulate the activity of key enzymes involved in seed metabolism, such as those responsible for the breakdown of stored reserves (Fan *et al.*, 2022).
- **Stress Tolerance:** Similar to Vitamin C, NO contributes to the plant's antioxidant defense system, helping to mitigate oxidative stress during germination under unfavorable conditions (Mur *et al.*, 2013).
- **Radical Growth:** NO can promote radical elongation and overall seedling vigor by influencing cell division and expansion in the embryonic axis (Fan *et al.*, 2022).

2.4 SEED PRIMING TECHNIQUES FOR ENHANCED GERMINATION

Seed priming is a pre-sowing technique in which seeds are partially hydrated under controlled conditions to activate key metabolic processes while preventing radicle protrusion. Following priming, the seeds are typically re-dried to their initial moisture content, enabling safe handling and storage. This treatment improves the speed and uniformity of germination and enhances seedling establishment, particularly under stressful environmental conditions (Farooq *et al.*, 2019; Paparella *et al.*, 2023).

2.4.1 OVERVIEW OF SEED PRIMING

The principle behind seed priming is to allow the seed to undergo the initial phases of germination (imbibition and metabolic activation) without completing the final phase (radical protrusion). This "head start" enables the seed to rapidly germinate once it is re-exposed to favorable moisture conditions. Benefits of seed priming include:

- **Faster and More Uniform Germination:** Primed seeds typically germinate more quickly and synchronously, leading to a more even plant stand (Heydecker *et al.*, 1975).
- **Improved Seedling Vigor:** Seedlings from primed seeds often exhibit enhanced vigor, stronger root development, and better early growth.
- **Increased Stress Tolerance:** Priming can induce physiological changes that enhance the seed's tolerance to various environmental stresses, such as drought, salinity, and temperature extremes (Mekonnen *et al.*, 2022).
- **Enhanced Enzyme Activity:** Priming allows for the repair of damaged cellular components and the activation of enzymes necessary for metabolism, leading to more efficient reserve mobilization upon rehydration.

2.5 GAPS IN CURRENT LITERATURE

Despite extensive research on seed germination and priming techniques, several critical gaps exist specifically for **common beans (Phaseolus vulgaris L.)**, particularly regarding differential varietal responses and the application of specific growth regulators:

1. **Comparative Responses of Seed Color Varieties to PGRs**

There's little to no research directly comparing how **brown-seeded** versus **whiteseeded** common bean varieties respond to exogenous applications of IAA, sodium nitroprusside (SNP), and Vitamin C despite known differences in seed coat composition that could affect uptake and physiological responses.

2. **Role of SNP (Nitric Oxide Donor) in Common Bean Germination**

A recent study optimized SNP seed-soaking to enhance germination in *Phaseolus vulgaris* under saline–alkaline stress, identifying 0.3 mmol L^{-1} for 12 hours as optimal (Wang *et al.*, 2025). However, there remains a shortage of studies comparing responses between different seed coat types or investigating broader physiological traits.

3. **Vitamin C (Ascorbic Acid) Priming Effects**

Although ascorbic acid's broader roles such as antioxidant regulation and epigenetic control which have been theorized in seed systems (MDPI, 2023), specific works on its priming effects in common bean germination and stress resilience are scarce.

4. **Optimal IAA Concentrations for Germination in Common Beans**

Some studies examine IAA's presence and dynamics in developing or germinating bean seeds (Cohen *and* Addison, 1989; Cohen, 1992), and others explore its impact in related species. Nevertheless, there's limited data on how various IAA concentrations influence germination performance and seedling vigor across different common bean seed types.

5. **Integration of Physiological Traits and Seed Coat Characteristics** While priming techniques have demonstrated improvements in germination rates and vigor (Amanpour-Balaneji and Sedghi, 2012), very few studies integrate physiological traits (e.g.,

antioxidant enzyme activity or dormancy status) with treatment effects and seed coat differences.

2.6 SUMMARY OF LITERATURE REVIEW

This literature review Emphasizing the importance of the common beans (*Phaseolus vulgaris* L.), as a staple food crop, particularly in West Africa and Nigeria to be precise and it highlights the nutritional value and contribution to food security and The intricate process of seed germination which is influenced by both internal and external factors are detailed in this Chapter, emphasizing the critical role of water uptake, metabolic activation, and hormonal balance in the germination and growth of the seeds and varietal differences, including those related to seed coat characteristics, have been identified as significant determinants of germination performance……………

The review also established the well-documented roles of plant growth regulators (PGRs) in modulating plant development. Indole-3-acetic acid (IAA) promotes cell elongation and root development, ascorbic acid (Vitamin C) acts as a crucial antioxidant mitigating oxidative stress, and sodium nitroprusside (SNP), as an NO donor, influences dormancy breaking and stress tolerance during germination. Seed priming techniques, which leverage these physiological principles, offer a promising avenue for enhancing germination uniformity and vigor………..

Despite extensive research, a significant knowledge gap exists regarding the comparative responses of white and brown cowpea seeds to varying concentrations of IAA, ascorbic acid, and SNP. This study aims to fill this void by providing specific, empirical data on these interactions, thereby contributing to more effective and tailored seed management strategies for improved cowpea production. That needs to be done

CHAPTER THREE

MATERIALS AND METHODOLOGY

3.1.1MATERIALS

- Petri dish .
- Beaker
- Plastic Bottles
- Filter paper
- Distilled Water
- Cotton woo**l**
- Measuring cylinder

3.1.2 EQUIPMENT

1. Weighing balance

3.1.3 CHEMICALS AND REAGENTS

- Sodium Nitroprusside
- Indole-3-Aetic Acid
- Vitamin C

3.2 SAMPLE COLLECTION

The sample was purchased on the **6th of July from** Ring-road, The reagents where provided By The Laboratory.

3.2 .1 SAMPLE PREPARATION

100,500, and 1000 ppm concerntration of each reagent where prepared and 180 viable seeds of both Brown and white beans sample where picked and 20 seed (10 seeds each of both varieties) where placed in 9 beakers. 20 ml of the different Concerntrations of reagent where used to prime the seed.

3.3 METHODOLOGY

3.3.1 PREPARATION OF REAGENT

A total of Nine (10) plastic bottles were thoroughly cleaned and labelled with each filled with 250 ml of distilled water.

- Growth regulator solutions of **100 ppm, 500 ppm, and 1000 ppm** were prepared as follows:

1. **100 ppm solution**: 0.025 g of the solute was weighed and dissolved in 250 ml of distilled water.
2. **500 ppm solution**: 0.125 g of the solute was weighed and dissolved in 250 ml of distilled water.
3. **1000 ppm solution**: 0.25 g of the solute was weighed and dissolved in 250 ml of distilled water.

3.3.2 SEED PRMINING

1. A total of Ten (10) beakers where prepared and labelled (,Vit 100ppm, 500ppm , 1000ppm , SNP 100ppm, 500ppm and 1000ppm, and IAA 100,500 and 1000ppm) and WATER
2. A total of 200 viable seeds, (100 of brown and 100 of white beans) where picked and set apart and 20 seeds(10 of each variety), where placed in each beaker.
3. 20ml of each Concerntration(100,500,1000ppm) of the Reagents (Vit C, IAA, SNP) where poured into the beaker containing the seeds, and the seeds were left to prime for

   30 minutes.
4. The same process was done for the Control (Water)
5. While the seeds where priming Ten (10) Petri dishes where prepared and labelled with each growth regulator and Concerntration and Water respectively. Afterwards an appropriate amount of cottonwool was spread in each Petri dish to act as the base for the plant and a source of Carbon
6. At the 30mins mark the seeds where implanted into the Petri dished containing the cotton wool and the variety was separated in the Petri dishes
7. Afterwards the growth was observed for a total of 120 hours

Plate 1.1: Plate showing germinating bean seeds in Petri dishes lined with cotton wool after 48 hours

Plate 1.2: Plate showing germinating bean seeds in Petri dishes lined with cotton wool after 72 hours

Plate 1.3: Plate showing germinating bean seeds in Petri dishes lined with cotton wool after 120 hours.

CALCULATIONS:

TO PREPARE 100ppm SOLUTION:

100mg (0.1g) of solute is dissolved in 1000ml of Distilled Water For

250ml:

0.1g = 1000ml

X = 250ml

Cross multiply the equation

X=25/1000 this would equal 0.25g

TO PREPARE 500ppm SOLUTION:

500mg (0.5g) of solute is dissolved in 1000ml of Distilled Water For

250ml:

0.5g = 1000ml

X   = 250ml

Cross multiply the equation

X=125/1000 this would equal 0.125g

TO PREPARE 500ppm SOLUTION:

1000mg (1g) of solute is dissolved in 1000ml of Distilled Water For

250ml:

1g = 1000ml

X   = 250ml

Cross multiply the equation

X=250/1000 this would equal 0.25g

TO GET MOISTURE CONTENT;

Wet weight – Dry weight= Moisture content

3.3.3 TRANSPLANTING INTO NURSERY

Raising crops in a nursery is important because it provides a controlled environment where young plants can be carefully managed during their early growth stages. In the nursery, seedlings are protected from harsh weather, pests, and diseases, while receiving adequate nutrients and water for healthy development. This system also ensures uniform and vigorous seedlings, reduces the amount of land and resources needed at the start, and gives farmers a chance to select only the healthiest plants for field planting. For this project work, using a nursery was essential for producing uniform and healthy bean seedlings, which allowed for more accurate assessment of how different growth regulators influenced germination and early growth.

1. A total of ten (10) plastic bottles were cut in half , Labelled and filled with sand to act as the nursery.
2. Water was used to soak the sand in the Nusery to prevent dryness and to aid the growth of the plant
3. 2 seedlings each from each of the Concerntration where transplanted into the nusery and allowed to grow for a total of 4 days before transferrring into the Field.

Plate2.1: Bean seedlings after transplanting into nursery soil after 120 hours.

3.3.4 FIELD PREPARATION AND TRANSPLANTING

Transplanting seedlings from the nursery to the main field is crucial because it allows plants to grow in wider spaces with adequate access to soil nutrients, water, and sunlight. This step ensures proper plant population, reduces competition among crops, and encourages stronger root establishment. By transplanting only healthy and well-developed seedlings, farmers increase the chances of better crop survival, higher yields, and improved overall productivity in the field. For this project, transplanting to the field was necessary to observe how the bean seedlings responded to natural conditions after initial nursery growth, and to evaluate the overall effect of the applied growth regulators on their survival, establishment, and performance under field conditions.

1. The field was first prepared by clearing and tilling the soil,
2. Each of the nursery bottle were watered before uprooting to soften the soil and reduce root damage.

3. 10 holes were digged and prepared in the field, and the seedlings were placed into the holes and soil was added to cover the roots and make rigdges to prevent water logging.

4. Regular aftercare practices such as irrigation, weeding, and pest control were carried out to ensure proper growth and development.

Plate 2.2: Image of bean seedlings transplanted into the field after nursery growth.

Plate2.3: image of the grown Beans after 2months of observation

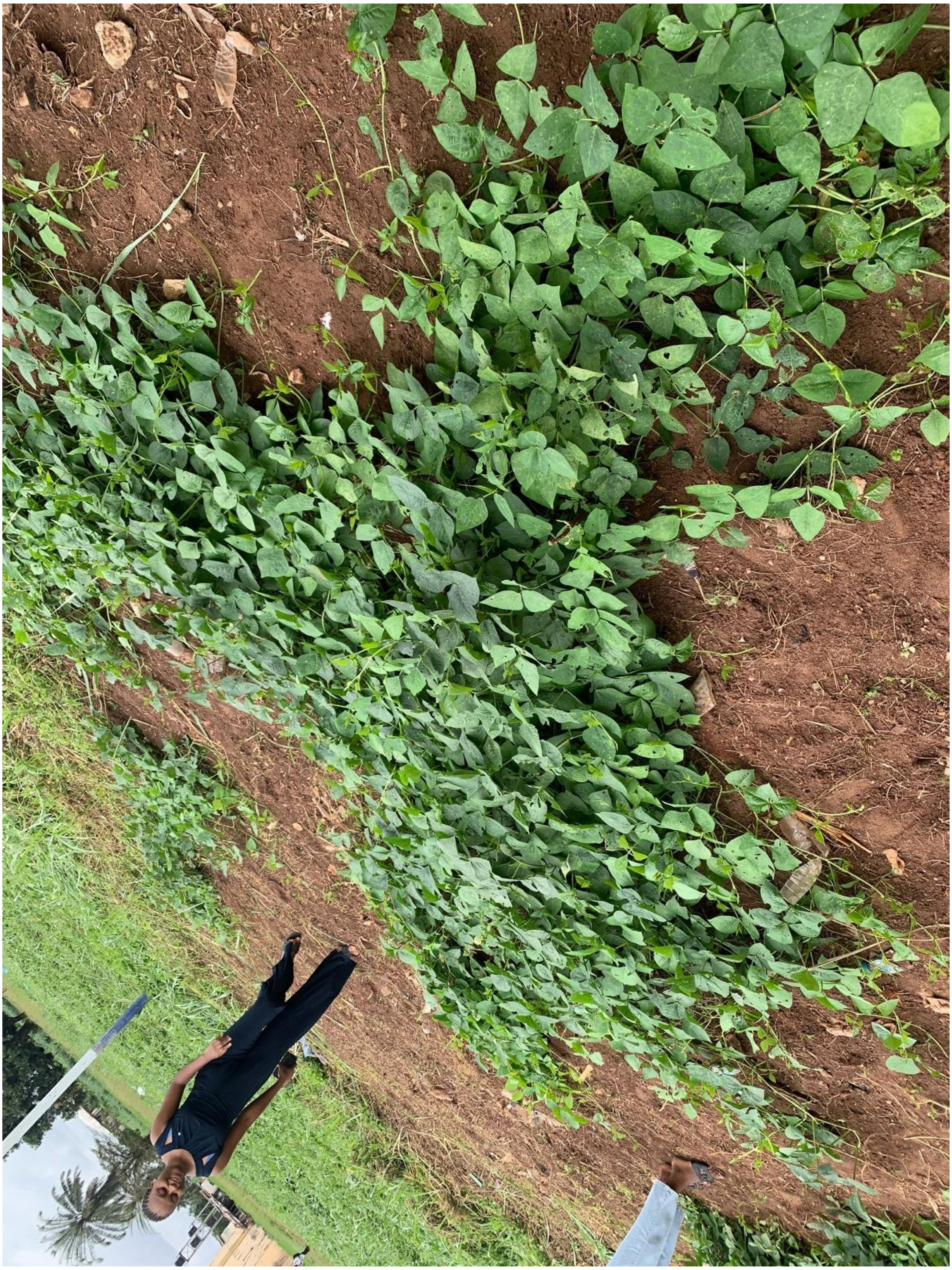

Plate 2.4 An image showing the plant growth after 3 months of observation

CHAPTER FOUR

4.0 RESULTS

This chapter presents the results of the Germination rate analysis of common beans (*Phaseolus vulgaris*) grown with different growth regulators; Sodium Nitropusside (SNP), Vitamin C (VITc) and INDOLE-3- Acetic Acid (IAA)by The results are arranged to show how each growth regulator affects the growth and nutritional makeup and germination rate of the beans.. For clarity, the results are displayed in tables and figures, together with statistical analysis to assess the importance of the discrepancies that were noticed.

4.1 GERMINATION RATE RESULTS

Table 1.0 table showing Germination rate results.

Samples	No of germinated seeds	Shoot length(cm)	Root length(cm)	No of roots	Wet weight	Biomass	Moisture Content
Water (control) bb	10	4.3	2.2	11	2.93	0.53	2.4
Water (control) wb	5	6	2	8	2.15	0.52	1.63
SNP100ppm bb	4	10	3	6	1.68	0.46	1.22
SNP100ppm wb	5	10	0.8	2	1.16	0.15	1.01
IAA100ppm bb	4	16	2	5	1.21	0.36	0.85
IAA100ppm wb	3	8.4	4	5	1.15	0.26	0.89
VITc 100ppm bb	10	23.5	1	15	0.81	0.23	0.58
VITc 100ppm wb	10	8.4	1	10	1.14	0.44	0.7
SNP500ppm bb	5	7	0.5	12	0.51	0.17	0.34
SNP500ppm wb	7	5	1.5	3	0.3	0.03	0.27
IAA500ppm bb	8	0	4.5	6	1.12	0.23	0.89

IAA500ppm wb	7	11	4	7	1.4	0.52	0.88
VITc 500ppm bb	8	8.9	4	15	1.64	0.63	1.01
VITc 500ppm wb	10	9.5	5.8	6	0.72	0.55	0.17
SNP 1000ppm bb	4	2	1	4	0.72	0.27	0.45
SNP1000ppm wb	3	7	0.8	0	0.65	0.06	0.59
IAA1000ppm bb	0	0	0	0	0	0	0
IAA1000ppm wb	2	4	1	0	0	0	0
VITc 1000ppm bb	5	3.4	2	4	0.83	0.29	0.54
VITc 1000ppm wb	10	13.5	1.6	2	0.94	0.3	0.64

KEY WORDS :

SNP = Sodium Nitropusside

IAA = Indole-3-Acetic acid

VITc = Vitamin C

bb = Brown beans

wb =White beans

4.2 FIELD OBSERVATION:

Table 1.2: Table showing the parameters gotten from field observation.

Sample	Lenght Of Spread (cm)	No. Of Branches	No. Of Leaves	Dry Weight of Spread
CTR	247	3	88	9.3
Vit C 100ppm	196	4	131	9.59
IAA 100ppm	200	2	75	9
SNP 500ppm	239	7	198	22.96

KEY WORDS:
CTR :WATER
Vit C : Vitamin C
IAA: indole-3- Acetic Acid
SNP: Sodium Nitro Pusside

Table 1.3 Number of pods produced from commonbeans treated with different growth regulator concentration

SAMPLE	NO OF PODS
CTR	2
VitC 100ppm	2
VitC 500ppm	2
VitC 1000pm	0
IAA 100ppm	1
IAA 500ppm	0
IAA 1000ppm	0
SNP 100ppm	2
SNP 500ppm	3

SNP 1000ppm	3

KEY WORDS:
CTR :WATER
Vit C : Vitamin C
IAA: indole-3- Acetic Acid
SNP: Sodium Nitro Pusside

Plate 3.1: An image showing the spread of the plant grown with IAA concentration

Plate 3.2: an image of the the spread of the plant grown with SNP growth regulator

Plate 3.3: an image showing the spread of the plant grown with Vit C growth regulator

Plate 3.4 An image showing the spread of the Control (Water)

Plate 3.5 A picture showing the bean pod produced under 100 ppm VitC treatment after 4 months

Plate 3.6: A picture showing the bean pod produced under 100 ppm IAA treatment after 4

Plate 3.7: An image showing the bean pod produced under 100 ppm SNP treatment after 4

Plate 3.8: An image showing the bean pod produced under 100 ppm SNP treatment after 4

Plate 3.8: An image showing the bean pod produced under 100 ppm SNP treatment after 4 months of observation**.**

OBSERVATION:

1. It was observed at the 30hour Mark that the SNP batch of seeds showed discoloration and the seeds where blackish in color, this discoloration progressed through out the germination period
2. Maggots where observed in the 100ppm of IAA and all Concentration of SNP at the 120 hours mark
3. The Most Vegetative growth Was observed in the Vitamin C Concentrations
4. After 120 hours, Leaves where observed in all the growth regulators Concentration except The SNP batch and 100ppm of IAA
5. SNP showed massive growth in the field with a onger spread compared to the other growth regulators
6. IAA especially the 1000ppm concentration showed the least amount of growth in the field
7. During the first month of growth there was pest attack on the plants and SNP growth concentration samples where majorly affected
8. Massive vegetation, spread and flowering where observed by the four month mark, the plants started producing pods after four months of growth marking the onset of the reproductive stage

CHAPTER FIVE

5.1 DISCUSSION

From the research conducted, we understand that the Common beans (*Phaseolus vulgaris* L.) are a vital legume in Nigeria, and it widely appreciated for their nutritional value and contribution to food security. And from the results this study examined how different growth regulators Indole-3-Acetic Acid (IAA), Vitamin C (Vit C), and Sodium Nitroprusside (SNP) affect the germination and early growth of brown and white bean varieties. From the results, it was observed that the type and concentration of growth regulators had a significant impact on seedling development. SNP-treated seeds showed the best overall growth, with greater shoot and root development and wider field spread compared to other treatments, indicating strong early establishment and vigor. Vitamin C also enhanced vegetative growth, promoting longer shoots and more leaves, but to a lesser extent than SNP. High concentrations of IAA, particularly at 1000 ppm, inhibited germination and reduced early growth, suggesting that excessive auxin can negatively affect seedling establishment. Inspection further revealed that while SNP was highly effective in promoting growth, it was associated with some seed discoloration and pest susceptibility.

5.2 CONCLUSION

In conclusion, the study demonstrated that growth regulators influenced the germination and early development of common beans in a significant. SNP proved to be the most effective regulator overall, promoting strong root and shoot growth and better field establishment. Vitamin C also enhanced vegetative performance, while high concentrations of IAA negatively affected germination and growth. These findings emphasize the importance of choosing suitable growth regulators and concentrations to achieve optimal results in bean cultivation.

5.3 RECOMMENDATION

Based on the findings of this Research, it is recommended that Sodium Nitroprusside (SNP) should be applied at moderate concentrations as a seed priming agent to enhance germination rate and early growth in common beans. Because Its ability to promote strong root and shoot development makes it a valuable tool for improving field establishment.

Vitamin C should also be promoted as an alternative, especially in environments where plants are exposed to stress. In this research see see that it’s antioxidant properties help improve seedling vigor and overall plant health. However, high concentrations of Indole-3-Acetic Acid (IAA) should be avoided, as they were found to suppress germination and reduce early growth performance.

Future research should focus on the long-term effects of these growth regulators on yield, pest resistance, and soil interaction under various environmental conditions. Lastly, it is important that farmers and researchers take into account the differences between bean varieties, as brown and white beans may respond differently to each growth regulator.

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