EFFECT OF TREAMENT WITH BIOPESTICIDES ON THE GROWTH AND HEALTH OF Telfairia occidentalis HOOK. F

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DEPARTMENT OF PLANT BIOLOGY

AND BIOTECHNOLOGY.

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A THESIS WRITTEN IN THE DEPARTMENT OF PLANT BIOLOGY AND BIOTECHNOLOGY, FACULTY OF LIFE SCIENCES, UNIVERSITY OF BENIN IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF SCIENCES (B.SC) (HONOURS) DEGREE IN BOTANY

FEBRUARY, 2025

CERTIFICATION

We certify that this research work was carried out by Abigail Oluwatobiloba Faleyimu (Miss) of the Department of Plant Biology and Biotechnology, Faculty of Life Science, University of Benin, Benin City, Nigeria.

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Prof. B. O Edegbai Date

Project Supervisor

Signed: ___________ ______________

Prof. E. D Vwioko Date

Head of Department

DEDICATION

This work is dedicated to God Almighty for His love, kindness, and guidance; to my esteemed parents, Mr. and Mrs. Faleyimu, and my honorable supervisor, Prof. B. O. Edegbai.

ACKNOWLEDGEMENTS

I give my highest honor to the Almighty God, who has been my unwavering support from the very beginning until this moment. His name is truly mighty on the throne, granting me life, good health, and the strength to complete my academic journey.

I also extend my heartfelt gratitude to my esteemed project supervisor, Prof. B. O. Edegbai, for his warmth, guidance, and unwavering support. Sir, may God continue to bless you and your family, as you were always there for me, especially during challenging times in my project work.

To my beloved Father, Mr. Anthony Faleyimu who have been supporting me both in cash and words of encouragement, I love you so much. To my Mom Late (Mrs) Victoria Faleyimu, thank you for your constant prayers and words of encouragement, Keep resting in the bosom of the Lord. And also to my dear sister whose constant love and encouragement have been invaluable.

Finally to my beloved friends Uyi, Dora, Simeon and Mirabel, I deeply appreciate your unwavering support throughout my studies.

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ABSTRACT

Biopesticides, often known as biological pesticides, are compounds made from biological agents that control agricultural pests to increase crop yields. The general aim of using the term biopesticide is to suggest a biological rather than a synthetic origin of the active agent, and implicit is a level of environmental and mammalian safety resulting from the use of naturally derived active. *Telfairia occidentalis* is an edible vegetable that is high in protein, vitamins, iron, calcium, and other nutrients that are necessary for a healthy diet. The purpose of this study was to examine the effects of biopesticides on *Telfairia occidentalis.*

This study was grouped into seven (7) biopesticides options compared to the control which no biopesticide was applied to. The biopesticides includes (Grinded pepper, garlic, and soap), (Grinded pepper and garlic), (Pepper, garlic and soap), (Pepper and garlic), (Neem oil and soap), (Neam oil) and lastly (Firewood ash). This study was carried out within 13 weeks, and the study was on different aspects of the plant growth which includes the plant height, the number of primary branches, leaf area, petiole length, tendril length, number of leaves, internodes, leaf chlorosis occurrence, and percentage of forage leaves. Across all aspects of the growth the *Telfairia occidentalis* treated with the biopesticides had significant increase compared to the control, which simply indicates positive effects across all. This study indicates that the biopesticides used are good pest control agents as a result of the growth and the good health of the plant. Asides from the fact that most of these biopesticides are good pest controlling agents, some are also a good agent for soil PH correction such firewood ash, and this also contributed to the growth and healthy profile of *Telfairia occidentalis* in the study.

CHAPTER ONE

INTRODUCTION

The world's population is expected to grow exponentially and reach 9.7 billion people by 2050, with Africa and Asia accounting for the majority of this number. The use of pesticides dates back to ancient civilizations. Early practices, such as the Sumerians using sulfur compounds around 2500 BCE and the Chinese employing mercury and arsenic-based compounds by 1000 BCE, marked the beginnings of pest control (Raffa *et al.,* 2021). This has imposed a large burden on agriculture and its allied sectors in terms of meeting food demands, which requires more inputs of for crop production. The environment and ecosystems have been negatively impacted by anthropogenic activities, which have also reduced agricultural area due to construction, increased nutrient mining, contaminated and degraded water resources (causing scarcity), accumulated xenobiotics soils, and degraded and deteriorated soil fertility, efficiency, and quality, with implications for soil erosion and climate change. It is necessary to find new and improved methods as well as increase the productivity and sustainability of agricultural practices in order to overcome these obstacles and satisfy the demands for food and supplies. These numerous strategies to increase agricultural productivity, including reducing yield loss from harsh environment circumstances (such as biotic and abiotic stresses) or improving crop output by applying manure and organic-based treatments such as pesticides (Pathak *et al.,* 2018). Because of their detrimental side effects, chemical pesticides used to protect crops and lessen the harm that pathogens and pest inflict in agricultural fields provide several long-term risks and hazards to living things. They have been linked to fetal deficts and malignancies (Kalafati *et al.,* 2018). The controlled and uncontrolled use of pesticides along with unquestionable benefits can also affect other living organisms, including human beings and plant metabolism by causing abiotic stress in plants (Monica *et al.,* 2012). Through non-specific processes or by interfering with the important biosynthesis steps, pesticides can affect the quantities of secondary metabolites such as flavonoids, hydroxycinnamic acids, anthocyanins, tropane alkaloids, and volatile terpenoids. By altering the volatile oils chemical composition, particularly the harmful or beneficial components, their quality can be changed. Furthermore, volatile oils have the ability to dissolve pesticide residues. Additionally, pesticides have the ability to alter plant metabolism, which can impact the rate at which micronutrients are absorbed (Monica *et al.,* 2012). The purpose of pesticides is to eradicate insects and other pests that threaten and damage crops. For ages, many insecticides have been employed to protect crops. Although pesticides helps crop, they have detrimental effect on the ecosystem. Overuse of pesticides has the potential to destroy biodiversity (Isra *et al.,* 2016). Chemical agents have been employed in pest control for centuries, but during the second half of the nineteenth century their use intensified considerably (Jose *et al.,* 2019). Pesticides come in three different varieties. They are carbomate, organochlorine, and organophosphate chemicals. Organophosphorus chemicals are notable for their increased biodegradability, limited persistence, and selective toxicity. Chlorinated hydrocarbons are more lipophilic than organophosphates. Organophosphate pesticides are employed more frequently and have supplanted more durable organochlorine chemicals due to their quick biodegradability. One-third of all pesticide poisoning cases worldwide occur India (Mohammad *et al.,* 2020). The introduction of herbicides and fungicides in the 1970s and 1980s, as well as the advent of additional synthetic insecticides, such as organophosphate (OP) insecticides in 1960s, carbamates in the 1970s, and pyrethroids in the 1980s, significantly increased agricultural productivity and pest control. A pesticide should ideally kill the intended pests but not humans other non-target species. Sadly, this is untrue, and as a result, the issue of pesticide use and abuse has emerged. According to the proverb “if little is good, a lot more will be better”, the widespread usage of these chemicals has had a disastrous effect on plants (Aktar *et al.,* 2009). The use of botanicals for crop protection is gaining popularity again because synthetic pesticides are too expensive and the ongoing use of these chemicals pollutes the environment. Research on using plants to combat agricultural pests and diseases and lessen the losses they cause is currently being vigorously pursued by agricultural entomologists, nematologists, and pathologists worldwide (Prakesh *et al.,* 2018). Researchers are now more interested in botanical pesticides after learning about the harm that synthetic pesticides cause to the environment and other non-target creatures. Botanical pesticides are biodegradable and do not leave traces in plant systems, unlike synthetic chemical pesticides. Since ancient times, plant extracts have been untilized in agriculture and other fields, particularly in India , to control insect and other pests. To reduce the use of synthetic pesticides, researcher have been searching for and locating environmentally acceptable plant-based insecticides in the past year (Haritha *et al.,* 2021).

1.1 TAXONOMY (*Telfairia occidentalis)*

Telfairia occidentalis is an edible vegetable, rich in essential diet components and contains protein, vitamins, iron, calcium and other nutrients (Bello *et al.,* 2013). It is indigenous to the west tropical rainforest area from Bendel to Cross Rivers states in Nigeria (Eseyin *et al.,* 2014). In several languages and nations *Telfairia occidentalis* is commonly referred to as follows: oil nut, fluted gourd, oyster nut, fluted pumpkin, and Telfairia nut (in English); Ugwu (Igbo-Nigeria), Aworoko, Ewekoro (Yoruba-Nigeria), Ikong (Efik/Ibibio-Nigeria), Krobonko (Ghana), Oroko, Pondokoko, and Gonugbe (Sierra Leone), and Costillada (Spanish) (Eseyin *et al.,* 2014) The huge perennial plant *Telfairia occidentalis* climbs via bifid and tendrils, which are typically coiled. Particularly when young, the stem’s five ridges are frequently coated in multicellular hairs. The plant's leaves are compound, often 3-5 foliate, and have multicellular hairs covering the blades and petioles. The fruits are among the largest known (16-50cm in length, 9cm in diameter), and they are identified by ten prominent longitudinal ridges. The big, non-endospermic, and often dark red seeds are lodged in a brilliant yellow fibrous endoscarp (Eseyin *et al.,* 2014).

1.2 SCIENTIFIC CLASSIFICATION OF (*Telfairia occidentalis*)

Kingdom – Plantae

Subkingdom – Viridaeplantae

Division – Tracheophyta

Subdivision – Spermatophytina

Infradivision – Angiospermae

Class – Magnoliospsida

Family – Cucurbitaceae

Genus - Telfairia

Species – Telfairia occidentalis

PROPAGATION, GERMINATION AD DEVELOPMENT:

The seeds of fluted pumpkin are viviparous, meaning they germinate inside the fruit. Once the seeds are removed from the fruit, they cannot be kept for longer than three days due to their recalcitrance (Afolayan *et al.,* 2010).

NUTRITIONAL BENEFITS:

Telfairia occidentalis is grown for its edible seeds and leaves. Seed are used to propagate it. High levels of fat (18%), vitamins, and minerals (20%), proteins (29%) and phytochemicals are present in this green vegetable. The leaves are rich in phosphorus, zinc, calcium, copper, and iron (Akanbi *et al.,* 2007). It is a medicinal plant which contains substances that can be used for the synthesis of drugs (WHO, 2015).

ETHNOBOTANICAL SIGNIFICANCE AS A FOOD AND CASH CROP:

T.occidentalis, a member of the Curucubirtae family, is native to the rain forest region of West Africa, which is located between latitudes 5^0 and 6^0 N and longitudes 7^0 and 8^0 E. This perennial tropical vine can withstand drought and is cultivated for its edible seeds, succulent shoots, and green leafy veggies (Akanbi *et al.,* 2007). In traditional contexts, *T.occidentalis* is utilized as a blood tonic. In Nigeria, anemia and diabetes are treated with herbal concoction of this underused shrub (Terefe *et al.,* 2020). To rapid raise blood level, it can be combined with milk or malted beverages and consumed. The ethnobotanical application of *Telfairia occidentalis* are not specifically covered in any report. Despite this, there is a growing scientific knowledge of this precious vine.

1.3 WHAT ARE BIOPESTICIDES?

The term ‘biopesticide’ encompasses a broad array of microbial pesticides, biochemicals derived from micro-organisms and other natural sources, and possesses involving the genetic incorporation of DNA into agricultural commodities that confer protection against pest damage. Some microbial pesticides such as Bacillus thuringiensis, have a long history of safe and effective use as a biological insecticide (Daniel, 2003). The general aim of using the term biopesticide is to suggest a biological rather than a synthetic origin of the active agent, and implicit is a level of environmental and mammalian safety resulting from the use of naturally derived active. Various subgroups of biopesticides that could be included under a broad definition comprise packaged pesticides based on live microbes, nematodes, microbial and plant extracts, genetically modified plants, semiochemicals, endophytes, invertebrates used inundatively, and other compounds derived from animals or minerals (Nolet *et al.,* 2015).

1.4 LITERATURE REVIEW

Pesticides are natural or synthetic agents which are designed to kill or reduce or repel insects, weeds, rodents, fungi or other organisms (Megha *et al.,* 2018). In the 19th century, innovations like copper sulfate and lime mixtures provided effective means to combat fungal diseases. The discovery of synthetic pesticides such as DDT during World War II revolutionized agriculture but also raised environmental and health concerns, leading to its ban in many countries (Schug *et al.,* 2016). They are classified in various ways based on their target, chemical structure, and mode of action. Due to the large amount of chemicals and pesticides combination of compounds have been classified for use in insecticides, miticides, herbicides, nematicides, fungicides, molluscicides, and rodenticides (Garcia *et al.,* 2018). The most common way to classify them based on their chemical structure is split into four main groups which includes organochlorine, organophosphate, carbamates, and pyrethroids. Organochlorine are mainly used in the eradication of disease vectors such as malaria, dengue (Garcia *et al.,* 2018). Its way of exposure is mainly on insects by contact or by ingestion (Ferrer 2003). Organophosphates are esters derived from phosphoric acid (Adeyinka *et al.,* 2023). Carbamates are esters derived from acids or dimethyl N-methyl carbamic acid and used as insecticides, herbicides, fungicides and nematicides (Gupta, 2014). And lastly Pyrethroids which originate from natural insecticide derived from pyrethrum extract derived from chrysanthemum flowers, known as pyrethrins (Casida 2009). Synthetic pesticides are often non-selective, affecting non-target organisms, and they persist in the environment, leading to bioaccumulation and health risks such as endocrine disruption, neurological disorders, and carcinogenicity (Mnif *et al.,* 2011). Moreover, the overuse of synthetic pesticides has caused resistance in pests, rendering many formulations less effective over time (Sparks *et al.,* 2015). Long-term exposure links to cancer, neurological disorders, and endocrine disruption (Mnif et al., 2011). Persistent pesticides reduce microbial diversity, affecting soil fertility (Mishra *et al.,* 2020). For many years, research and promotion have focused on biopesticides, which are based on living microbes and their bioactive chemicals, as alternatives to synthetic pesticides (Glare *et al.,* 2012). It encompasses a broad array of microbial pesticides, biochemical derived from micro-organisms and other natural sources, and processes involving the genetic incorporation of DNA into agricultural commodities that confer protection against pest damage (plant-incorporated protectants) (Sudakin 2003). Without endangering the biological cycle or exacerbating environmental contamination, biopesticides are highly effective at contolling agricultural pests (Leng *et al.,* 2011). Biopesticides and biofertilizers are not new technology; they are naturally occurring formulations of compounds that control pests in an environmentally benign and non-toxic manner. Since the dawn of human history, they have been employed in a variety of ways. Because they are living things (natural enemies), biopesticides can be used to control pests because they are less harmful to the environment and human health. The microbial biopesticides Bacillus thuringiensis, or Bt, is one of the most commonly utilized. The application of biopesticides has significant potential advantages for public health initiatives and agriculture (Kumar *et al.,* 2015). The majority of biopesticides are a naturally occurring or made from substances found in living things or their byproducts. When compared to chemical insecticides, they only produce modest harmful effects (Nurruzzaman *et al.,* 2019). Biopesticides may be clearly distinguished from their synthetic counterparts for their natural origin, unique action modes, high specificity, narrow pest range, and also for their less use quantities (Razaq *et al.,* 2022). Biological control organisms can be employed whole or as their byproducts to produce biopesticides, which can be derived from naturally occurring pest antagonistic organisms, such as metabolites and genes (Bilgrami *et al.,* 2022). Based on the kinds of bioactive components or agent used for pest management, the US EPA has divided biopesticides into three main classes which includes biochemical pesticides, microbial pesticides and plant-incorporated protectants (Nurruzzaman *et al.,* 2019).

MICROBIAL PESTICIDES: They are products containing biocontrol agents as active ingredient including bacterial, fungi, viruses or protozoa (Razaq *et al.,* 2022). These diseases contain extremely species-specific active components, some of which are herbicides and others of which are bioinsecticides. Biopesticides are thought to be safer pesticides for non-target creatures in the ecosystem since they are less specific (Razaq *et al.,* 2022). This type of biopesticide can control several types of pests, although each active ingredient in particular acts toward a specific target pest (Villarreal *et al.,* 2023). There exist microorganisms that suppress weeds (bioherbicides), even though the majority of these agents target insect species (entomopathogens; product named bioinsecticides) (Sporleder *et al.,* 2013).

BIOCHEMICAL PESTICIDES: They are based on naturally occurring substances having same structure and function and control pests by non-toxic mechanisms (Razaq *et al.,* 2022). It fall into different biologically functional classes, including pheromones and other semiochemicals, plant extracts, and natural insect growth regulators (Sporleder *et al.,* 2013).

PLANT-INCORPORATED PROTECTANTS: They are transgenes incorporated into plant materials and responsible for producing pest management compounds, the protein and its genetic material (Razaq *et al.,* 2022).

As they get better and stronger throughout time, their use has grown. Increased insect resistance, the ban on synthetic pesticides, and the use of integrated pest management techniques led to a 10% increase in biopesticides as alternative agrochemicals and a 2% yearly decline in the use of synthetic pesticides (Gabriela *et al.,* 2023). Since the use of the biopesticides is markedly safer for the environment and users, and more sustainable than the application of chemicals, their use as alternatives to chemical pesticides, especially as components in Integrated Pest Management strategies, is of growing interest (Sporleder *et al.,* 2013).

1.4.1 Adverse effects of synthetic pesticides

Air pollution can be caused by pesticides. When pesticide particles in the air are blown by the wind to other locations, they may contaminate other places. This phenomenon is known as pesticide drift (Cornell University, 2007). The amount of inhalable pesticides in the outdoor environment is therefore often dependent on the season (Damalas *et al.,* 2011). Volatile organic compounds, which are released by pesticides sprayed on fields and used to fumigate soil, can combine with other chemicals to create tropospheric ozone, a pollutant. About 6% of all tropospheric ozone levels are caused by pesticide use (Oaya *et al.,* 2019).The effect of pesticides on human health depend on the toxicity of the chemical and the length and magnitude of exposure (Lorenz, 2009). In the past several decades, amphibians population have declined across the world, for unexplainable reasons which are thought to be varied but of which pesticides may be part (Cone, 2000). They do not always stay in the location where they are applied (Oaya *et al.,* 2019). Synthetic pesticides has strongly deleterious impacts on the biocontrol agents i.e lethal (mortality over time), and sublethal (oxidative stress) effects (Valeria *et al.,* 2021). Synthetic pesticides are lethal to a host of living organisms, be it insect, weed, rodent, etc (Ankit *et al.,* 2020).They are also responsible for the deterioration of soil quality. Because pesticides disturb all natural ecosystems, especially soil and aquatic ecosystems, their detrimental effects on non-target creatures are readily apparent. As a result, the use of a number of pesticides is prohibited (Villarreal *et al.,* 2023).

1.4.2 AIM AND OBJECTIVE OF PROJECT RESEARCH

AIM: To provide an alternative to synthetic pesticide using *Telfaria occidentalis*

OBJECTIVES

The objectives of the study are to:

1. Determine the efficacy of the biopesticides on *Telfaria occidentalis.*
2. Evaluate the effect of the biopesticides on the plant growth.

CHAPTER TWO

MATERIALS AND METHODOLOGY

2.1 Study Area

The study was carried out at the Botanical Garden, University of Benin

2.2 Collection and Identification of Samples

2.2.1 Source of Seed

The seeds of *Telfaria occidentalis* used in the experiment were bought from Ring-road market, Benin. The pods were opened transversely and viable seeds were selected.

2.2.2 Source of Soil

The seeds were planted through ground planting. The soil was obtained from a fallow ground at the Botanical Garden, University of Benin.

2.2.3 Source of Treatments (Firewood ash, Pepper, Garlic, Soap, Neem oil and Pesticide)

All treatments were bought weekly from Ring-road market.

2.3 Treatment Preparation and Application

2.3.1 Treatment Preparation

Neem oil (NO)

15ml of neem oil + 3.8L of water

Neem oil and Soap (NOS)

15ml of neem oil +5ml of detergent + 3.8L of water

Chopped Pepper and Garlic with Soap (PGS)

Well chopped (25 Chili pepper + 12 gloves of garlic) + 10ml of soap + 1L of water

Chopped Pepper and Garlic (PG)

Well chopped (25 Chili pepper + 12 gloves of garlic) + 1L of water

Grinded Pepper and Garlic with Soap (GPGS)

Well blended (25 Chili pepper + 12 gloves of garlic) + 10ml of Soap + 1L of water

Grinded Pepper and Garlic (GPG)

Well blended (25 Chili pepper + 12 gloves of garlic) + 1L of water

2.3.2 Treatment Application

All treatments were applied florally

2.4 Experimental Set Up

This study was carried out using eight treatments identified as follows;

CTRL- Control (nothing was applied to the plant)

FWA- Firewood ash was sprinkled to cover each leaf on the plant

GPGS- Grinded pepper and garlic with soap was applied florally on the plant

GPG- Grinded pepper and garlic was applied florally on the plant

PGS- Chopped pepper and garlic with soap was applied florally on the plant

PG- Chopped pepper and garlic was applied florally on the plant

NOS- Neem oil and soap was applied florally on the plant

NO- Neem oil was applied florally on the plant

All treatments were in three replicates and a seed per hole of *T. occidentalis.*

2.5 Parameters of Study

2.5.1 Measurement of Plant Height

The height of the plant was measured from the terminal bud to the base of the plant. It was done with the use of a measuring tape and was taken weekly

2.5.2 Measurement of Stem Girth

The stem girth was measured 3cm above the ground. With the aid of a thread and a tape rule, the thread is used to obtain the circumference and with aid of a formula the stem girth is obtained.

$D=\pi/C$

Where D is the stem girth

C is the circumference of the stem

2.5.3 Determination of Leaf Number

The number of leaves were counted and recorded for each plant weekly

2.5.4 Measurement of Internodes

The internode was measured by measuring the distance 5^{th} and 6^{th} node from the base of the plant

2.5.5 Measurement of Leaf Area

Leaf area was determined by measuring the length and breadth of the fifth leaf from the base

$A= L\times B\times 1.09$

Where A is the leaf area

L is the length of leaf

B Is the breadth of leaf

2.5.6 Number of Tendrils

The number of tendrils were counted were counted and recorded on each plant every week

2.5.7 Measurement of Longest Tendril Length

The longest tendril was ascertained and then measured with a tape rule and recorded

2.5.8 Measurement of Leaf Stalk Length

The length of leaf stalk was measured for the fifth leaf with a measuring tape and recorded

2.5.9 Number of Leaflets with Chlorosis

Leaflets experiencing chlorosis were counted and recorded

2.5.10 Number of Leaflets with Necrotic Spots

Leaflets with necrotic spots were counted and recorded

2.5.11 Prominent Foliar Colour

The prominent colour of the leaves on each plant was recorded with the aid of a

Colour chart

2.5.12 Number of Leaflets with Evident Foraging

The leaflets attacked by pest were counted and recorded

2.5.13 Number of Primary Branching

The number of primary branching was counted and recorded

2.6 Statistical Analysis

The results were subjected to a mean, standard deviation and standard mean analysis, to determine if there was any statistical significance between the physiological characters observed in *T. occidentalis*

CHAPTER THREE

RESULTS

The results were taken from week 3 to week 13 and two-week intervals.

Table 1 shows the plant height across different treatments. All treatments increased in height compared to the control (CTRL). At week 3, the CTRL measured 13.62, while FWA had a significantly higher height of 28.87. By the end of the study (week 13), the CTRL reached 116.73, with FWA slightly surpassing it at 135.33.

Table 2 shows the number of leaves across different treatments. All treatments increased over time compared to the control CTRL, At week 3, CTRL had 9.04 leaves, while NO had 12.93. By the end of the study (week 13), they reached 38.33 and 50.67, respectively.

Table 3 shows the internode across different treatments. All treatments gradually increased compared to the control CTRL. At week 3, CTRL had 2.81, while FWA had 2.91. By the end of the study (week 13), both had reached 9.19.

Table 4 shows the number of primary branches across different treatments. All treatments increased steadily compared to the control CTRL. At week 3, both CTRL and GPG had 1, but by the end of the study, CTRL increased to 2.0, whereas GPG remained at 2.67.

Table 5 shows the leaf area across different treatments. All treatments increased throughout the weeks of the study compared to the control CTRL.

Table 6 shows the tendril length across different treatments. All treatments progressively increased compared to the control CTRL. At week 3, CTRL measured 12.33, while NO and

FWA had 17.67 and 15.33, respectively. By the end of the study, CTRL reached 37.87, whereas NO and FWA increased to 40.32 and 38.28, respectively.

Table 7 shows the petiole length across different treatments. All treatments increased at the beginning of the study (week 3) compared to the CTRL..

Table 8 shows the leaf chlorosis occurrence across different treatments. All treatments exhibited an increase in leaf chlorosis compared to the control CTRL. At week 3, CTRL had 7.77, while FWA was significantly higher at 15.8. By the end of the study, CTRL reached 9.57, whereas FWA was 35.73.

Table 9 shows the percentage of forage leaves across different treatments. All treatments increased at the beginning of the study (week 3) compared to the CTRL, And towards the end of the study, they all maintain the increments.

Table 1: Effects of the various treatments on the plant height of *T. occidentalis*.

	TIME					
TREATMENTS	3 weeks	5 weeks	7 weeks	9 weeks	11 weeks	13 weeks
GPGS	24.82 ± 5.6	36.4 ± 8.2	106.59 ± 7.71	124 ± 3.51	132.67 ± 8.76	134.57 ± 12.48
GPG	14.5 ± 1.98	19.33 ± 2.91	102.56 ± 3.56	120.0 ± 4.04	124.96 ± 2.05	125.33 ± 12.35
PGS	16.64 ± 2.65	24.4 ± 3.89	105.01 ± 2.18	125.23 ± 2.47	129.88 ± 2.56	135.0 ± 4.36
PG	13.32 ± 0.6	19.53 ± 0.88	100.13 ± 2.51	123.33 ± 2.85	130.94 ± 1.47	139 ± 9.5
NOS	16.23 ± 0.78	23.8 ± 1.14	117.06 ± 9.41	118.93 ± 10.7	121.56 ± 3.78	125.07 ± 11.03
NO	15.21 ± 0.4	22.3 ± 0.59	111.88 ± 11.55	126.05 ± 10.42	127.13 ± 13.13	136.67 ± 16.6
FWA	28.87 ± 6.85	42.33 ± 10.04	101.2 ± 1.83	115 ± 2.08	128.4 ± 2.66	135.33 ± 5.46
CTR	13.62 ± 0.65	19.97 ± 0.96	102.73 ± 8.17	115.47 ± 10.11	116.1 ± 10.23	116.73 ± 9.28

Table 2: Effects of the various treatments on the number of leaves of *T. occidentalis.*

	TIME					
TREATMENTS	3 weeks	5 weeks	7 weeks	9 weeks	11 weeks	13 weeks
GPGS	10.28 ± 0.5	19.0 ± 0.58	21.67 ± 1.76	26.67 ± 2.33	39.67 ± 1.33	40.0 ± 4.16
GPG	5.0 ± 0.78	5.67 ± 0.88	20.67 ± 1.45	25.0 ± 1.73	37.67 ± 0.88	38.67 ± 5.7
PGS	8.53 ± 1.56	9.67 ± 1.76	22.67 ± 0.88	27.67 ± 0.88	32.67 ± 1.33	39.0 ± 2.31
PG	10.0 ± 3.07	11.33 ± 3.48	27.67 ± 1.86	33.33 ± 0.88	33.67 ± 2.4	38.67 ± 1.53
NOS	7.94 ± 0.88	9.0 ± 1.0	16.67 ± 0.67	23.67 ± 0.67	35.67 ± 0.88	39.33 ± 1.45
NO	12.93 ± 2.99	15.0 ± 3.06	36.0 ± 1.53	43.67 ± 1.76	49.33 ± 1.45	50.67 ± 1.86
FWA	6.3 ± 1.22	7.33 ± 1.2	25.0 ± 1.15	30.33 ± 1.45	36.33 ± 0.88	39.33 ± 3.84
CTR	9.04 ± 0.79	10.67 ± 0.88	21.33 ± 2.91	26.33 ± 3.48	37.67 ± 0.88	38.33 ± 1.2

Table 3: Effects of the various treatments on the internode of *T. occidentalis*

	TIME					
TREATMENTS	3 weeks	5 weeks	7 weeks	9 weeks	11 weeks	13 weeks
GPGS	2.17 ± 0.14	2.63 ± 0.19	5.87 ± 0.29	6.67 ± 0.33	8.67 ± 0.52	9.21 ± 0.34
GPG	2.36 ± 0.07	2.97 ± 0.09	4.69 ± 0.29	5.33 ± 0.33	7.33 ± 0.33	9.66 ± 0.33
PGS	2.61 ± 0.13	3.27 ± 0.16	4.81 ± 0.26	6.47 ± 0.29	8.7 ± 0.65	9.20 ± 0.6
PG	2.04 ± 0.03	2.56 ± 0.03	5.57 ± 0.29	6.33 ± 0.33	7.17 ± 0.44	9.26 ± 0.33
NOS	2.33 ± 0	2.92 ± 0	4.99 ± 0.29	6.67 ± 0.33	8.43 ± 0.3	9.20 ± 0.33
NO	2.74 ± 0.47	3.46 ± 0.6	5.28 ± 0	6.0 ± 0	8.33 ± 0.33	9.36 ± 0.33
FWA	2.91 ± 0.35	3.67 ± 0.43	6.66 ± 0.21	7.57 ± 0.23	8.57 ± 0.43	9.19 ± 0.19
CTR	2.81 ± 0.38	3.55 ± 0.5	5.69 ± 0.66	6.47 ± 0.75	8.63 ± 0.68	9.19 ± 0.61

Table 4: Effects of the various treatments on the number of primary branches of *T. occidentalis.*

	TIME					
TREATMENTS	3 weeks	5 weeks	7 weeks	9 weeks	11 weeks	13 weeks
GPGS	1.0 ± 0	2.0 ± 0	2.33 ± 0.33	2.33 ± 0.33	2.33 ± 0.33	2.67 ± 0.33
GPG	1.0 ± 0	1.0 ± 0	2.0 ± 0	2.0 ± 0	2.33 ± 0.33	2.67 ± 0
PGS	1.0 ± 0	2.0 ± 0	2.33 ± 0	2.44 ± 0	2.67 ± 0	3.0 ± 0
PG	1.33 ± 0.33	2.33 ± 0.33	3.33 ± 0.33	3.33 ± 0.33	3.33 ± 0.33	3.67 ± 0.33
NOS	1.0 ± 0	2.0 ± 0	2.33 ± 0	2.33 ± 0	2.67 ± 0	3.0 ± 0
NO	1.33 ± 0.33	2.33 ± 0.33	3 ± 0.58	3 ± 0.58	3 ± 0.58	3.67 ± 0.33
FWA	1.0 ± 0	2.0 ± 0	2.33 ± 0.33	2.67 ± 0.33	2.67 ± 0.33	2.67 ± 0.33
CTR	1.0 ± 0	2.0 ± 0	2.0 ± 0	2.0 ± 0	2.0 ± 0	2.0 ± 0

Table 5: Effects of the various treatments on the leaf area of *T. occidentalis*

	TIME					
TREATMENTS	3 weeks	5 weeks	7 weeks	9 weeks	11 weeks	13 weeks
GPGS	20.41 ± 0.84	29.93 ± 1.23	34.58 ± 3.28	37.67 ± 1.2	38 ± 3.61	53.79 ± 1.4
GPG	22.88 ± 3.2	30.36 ± 1.65	37.01 ± 2.12	40.67 ± 2.33	48.67 ± 2.03	52.54 ± 1.36
PGS	18.79 ± 0.77	27.56 ± 1.13	27.82 ± 1.17	30.57 ± 1.29	48.33 ± 1.86	53.81 ± 1.91
PG	17.58 ± 0.79	25.78 ± 1.16	29.67 ± 1.65	32.6 ± 1.81	45 ± 0.58	55.21 ± 0.77
NOS	21.42 ± 1.02	31.41 ± 1.5	39.43 ± 1.52	43.33 ± 1.67	49.67 ± 1.2	51.64 ± 1.36
NO	21.01 ± 0.63	29.43 ± 0.77	42.77 ± 5.33	47 ± 5.86	58 ± 7.09	61.75 ± 6.76
FWA	40.83 ± 11.72	43.38 ± 1.09	47.67 ± 1.2	55.67 ± 13.25	56.37 ± 3.36	59.71 ± 2.87
CTR	18.86 ± 1.31	26.35 ± 1.27	37.01 ± 2.12	40.67 ± 2.33	48.1 ± 2.55	51.59 ± 1.27

Table 6: Effects of the various treatments on the tendril length of *T. occidentalis.*

	TIME					
TREATMENTS	3 weeks	5 weeks	7 weeks	9 weeks	11 weeks	13 weeks
GPGS	9.19 ± 0.61	11.33 ± 1.33	20.13 ± 2.13	28.7 ± 9.67	30.18 ± 2.67	37.93 ± 3.03
GPG	9.19 ± 0.19	18.67 ± 0.88	20.07 ± 9.07	25.93 ± 1.02	27.93 ± 1.28	38.33 ± 1.45
PGS	13 ± 0.58	19.23 ± 0.62	24.05 ± 0.78	27.33 ± 0.88	32.77 ± 1.94	39.21 ± 1.12
PG	13.67 ± 0.88	19.93 ± 1.24	24.93 ± 1.55	28.33 ± 1.76	33.03 ± 1.49	39.21 ± 0.77
NOS	10.67 ± 0.88	15.24 ± 1.43	19.07 ± 1.78	26.67 ± 2.03	32.67 ± 1.86	40.11 ± 0.67
NO	17.67 ± 0.88	25.56 ± 1.24	31.97 ± 1.55	36.33 ± 1.76	39.57 ± 0.87	40.32 ± 1.19
FWA	15.33 ± 0.88	21.8 ± 1.77	27.28 ± 2.21	31 ± 2.52	37.07 ± 2.07	38.28 ± 2.16
CTR	12.33 ± 1.45	17.63 ± 2.45	22.06 ± 3.06	25.07 ± 3.47	36.13 ± 2.45	37.87 ± 2.38

Table 7: Effects of the various treatments on the petiole length of *T. occidentalis*.

	TIME					
TREATMENTS	3 weeks	5 weeks	7 weeks	9 weeks	11 weeks	13 weeks
GPGS	3.2 ± 0.57	4.69 ± 0.84	5.87 ± 1.06	6.67 ± 1.2	9.19 ± 0.61	38.73 ± 8.58
GPG	2.9 ± 0.29	4.22 ± 0.4	5.28 ± 0.51	6 ± 0.58	9.19 ± 0.19	39.37 ± 8.71
PGS	3.37 ± 0.26	4.92 ± 0.41	6.16 ± 0.51	7 ± 0.58	8.13 ± 0.47	37.91 ± 1.12
PG	3.87 ± 0.55	5.65 ± 0.81	7.07 ± 1.02	8.03 ± 1.16	8.47 ± 0.29	38.21 ± 0.77
NOS	2.73 ± 0.17	3.99 ± 0.23	4.99 ± 0.29	5.67 ± 0.33	9.33 ± 0.33	38.11 ± 0.67
NO	3.33 ± 0.29	4.88 ± 0.45	6.1 ± 0.56	6.93 ± 0.64	8 ± 1	40.32 ± 1.19
FWA	4.33 ± 0.74	6.09 ± 1.17	7.63 ± 1.47	8.67 ± 1.67	11.47 ± 2.31	38.28 ± 2.16
CTR	2.4 ± 0.29	3.52 ± 0.41	4.4 ± 0.51	5 ± 0.58	6.2 ± 0.92	37.87 ± 2.38

Table 8: Effects of the various treatments on the leaf chlorosis occurrence of *T. occidentalis.*

	TIME					
TREATMENTS	3 weeks	5 weeks	7 weeks	9 weeks	11 weeks	13 weeks
GPGS	10.73 ± 5.66	21.83 ± 5.07	26.2 ± 1.2	26.97 ± 5.51	52.4 ± 10.47	58.43 ± 15.4
GPG	12.3 ± 3.05	25.43 ± 2.98	27.5 ± 0.74	27.8 ± 1.68	57.13 ± 14.28	69.03 ± 15.62
PGS	34.33 ± 12.64	41.03 ± 4.64	45.4 ± 1.7	47.17 ± 4.09	62.53 ± 10.8	72.43 ± 9.59
PG	22.4 ± 5.45	34.27 ± 10.39	35.3 ± 11.01	35.87 ± 9.58	36.77 ± 2.27	44.07 ± 0.76
NOS	45.77 ± 6.88	53.47 ± 16.91	47.07 ± 6.87	59.27 ± 15.73	61.83 ± 8.17	66.67 ± 20.28
NO	44.7 ± 13.19	46.5 ± 10.47	27.77 ± 0.64	29.73 ± 2.07	26.3 ± 0.42	26.27 ± 0.41
FWA	15.8 ± 3.68	16.17 ± 2.88	18.4 ± 2.6	20.97 ± 2.4	34.9 ± 8.2	35.73 ± 12.16
CTR	2.57 ± 2.57	6.07 ± 6.07	7.77 ± 7.77	8 ± 3.27	9 ± 3.35	9.57 ± 2.74

Table 9: Effects of the various treatments on the percentage of forage leaves *T. occidentalis.*

	TIME					
TREATMENTS	3 weeks	5 weeks	7 weeks	9 weeks	11 weeks	13 weeks
GPGS	13.87 ± 7.02	17.77 ± 9.68	21.47 ± 11.26	21.53 ± 11.35	17.23 ± 6.28	28.93 ± 1.03
GPG	4.77 ± 4.77	9.57 ± 2.74	12.23 ± 6.09	13.07 ± 5.71	18.2 ± 6.31	26.97 ± 2.71
PGS	11.03 ± 1.91	12.5 ± 2.17	20.33 ± 3.16	22.57 ± 2.6	22.67 ± 3.71	28.33 ± 1.85
PG	12.93 ± 4.95	16.17 ± 2.38	23.83 ± 4.11	26.13 ± 2.76	27.23 ± 3.45	27.97 ± 1.56
NOS	12.93 ± 1.63	22.87 ± 2.87	55 ± 5.28	59.83 ± 1.41	62.03 ± 0.47	64.53 ± 0.47
NO	8.97 ± 2.62	11.13 ± 5.54	17.1 ± 0.1	17.8 ± 3.11	19.6 ± 3.35	29.6 ± 2.45
FWA	17.47 ± 4.09	24.9 ± 8.05	35.23 ± 11.4	36.67 ± 9.18	38.2 ± 10.05	46.77 ± 2.07
CTR	7.33 ± 3.78	6.47 ± 3.33	19.3 ± 5.96	19.07 ± 6.83	22.13 ± 4.56	26.9 ± 0.97

CHAPTER FOUR

4.1 Discussion

Biopesticides are naturally occurring substances or compounds that have the capacity to control pests through nontoxic mechanism; their mode of action differs significantly from that of chemical pesticides, which are composed of molecules that are synthesized in a lab and engineered to directly kill the pests (Sporleder *et al.,* 2021). The present study reported a significant increase in the growth stages of *Telfairia occidentalis* treated with Grinded pepper, garlic, and soap, Grinded pepper and garlic, Pepper and soap, Neem oil and soap. This is in line with the research conducted by (Gemma Johnstone, 2024) who reported an increase in the yield of plant treated with similar treatments. Garlic and pepper contain bioactive compounds that acts as natural pesticides and growth enhancers. Garlic pepper extracts have been successfully used to manage common pests of *Telfaria occidentalis* while improving plant health which is in line with the research conducted by (Wilson *et al*., 2021). There was significant increase in the ones treated with Neem oil, and Fire wood ash as well. This is in line with the research conducted by (Umoetak *et al.,* 2009) which suggests that the insect pest can be controlled by the use of neem seed or oil extracts because of the insecticidal properties of neem products. Neem oil has been successfully applied to protect *Telfairia occidentalis* from common pests and diseases, promoting healthier growth and higher yields which is in line with the research conducted by (Frank, 2013) who also reported increase in the plant height and yield of *Telfairia occidentalis*. The neem and its products are used in seed treatment, manurial application, and increasing nutrient efficiency (Subbalakshmi *et al.,* 2012). Neem oil contains saponins that are found to have antimicrobial activity that inhibits moulds and protecting plants from attack of insects (Chattha *et al.,* 2012). It is also in line with the research conducted by (Abana P.C, 2022) who also reported significant increase in the plant height of *Telfairia occidentalis* treated with wood ash. This indicates that wood ash can serve as a beneficial soil amendment for *Telferia occidentalis,* enhancing soil fertility and plant growth. Neem oil protects internodes from pest damage, ensuring steady elongation and structural strength as seen in this study whereby there was significant increase in internode. However, it's important to consider the potential increase in certain anti-nutritional factors, such as cyanogenic glycosides and tannins, which may have implications for consumption. Firewood ash contains potassium and calcium, which promote stem elongation, leading to longer internodes and increased vine growth as seen in the result whereby there was significant increase in the internodes. Enhancing its growth and protecting it from pests and diseases using organic amendments and natural pesticides can signicantly improve yield and sustainability as seen in the table indicating the study. Ashes generally have good acid-neutralizing capacity and ability to supply the soil essential elements (Olejeme *et al.,* 2023). Ashes treatments used significantly reduced the leaf spot disease of *Telfairia occidentalis* in the research conducted by (Bassey *et al.,* 2016). The phosphorus availability of wood ash varies considerably and utilizing wood ash as a soil amendment can offset or correct some nutrient deficiencies and imbalances (Scheepers *et al.,* 2016). Studies have shown that incorporating wood ash into soil improves plant height, leaf number and biomass yield. However, balanced application is necessary to prevent nutrient toxicity.

Aphids, scales, mealybugs, thrips, whiteflies, and the twospotted spider mite, Tetranchychus urticae, are among the soft-bodied insect and mite pests that are controlled by soaps that contain potassium salts of fatty acids as their active ingredients (Raymond, 2022). The pest control activity of the soap had a positive effect on the yield of *Telfairia occidentalis.*

Sulfuric chemicals found in garlic have the potential to regulate growth by optimizing internode length, ensuring a more compact and robust plant structure. The treatments showed positive effects on *Telfairia occidentalis* throughout the stages of the study, which indicates that they are beneficial treatments for enhancing the growth and health of *Telfairia occidentalis.* Pepper has capsaicin, which irritates and repels insects. Capsaicin is a phytochemical derived from plants of the genus Capsicum and the subject of intensive phytochemical research due to its important antimicrobial properties (Periferakis *et al.,* 2023). This is in line with the increase in yield, health and growth of the *Telfairia occidentalis* treated with grounded pepper as a good pest control.

4.2 Conclusion

In conclusion, this study reveals that the application of these treatments demonstrated significant positive effects on the growth, health and yield of *Telfairia occidentalis.* They serve as eco-friendly alternatives to synthetic fertilizers and pesticides, offering a sustainable approach to enhancing soil fertility, promoting plant vigor, and effectively managing pests and diseases.

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