BINDURA UNIVERSITY OF SCIENCE EDUCATION

DEPARTMENT OF NATURAL RESOURCES

NURSERY GROWTH PERFORMANCE OF FRUIT TREE CUTTINGS PROPAGATED USING DIFFERENT PRE-TREATMENTS IN BINDURA, ZIMBABWE

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DECLARATION

The undersigned certify that they have read this research project and have approved its submission for marking in relation to the department's guidelines and regulations.

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Signature: Date: 30/9/2024

Chairperson: W. Mhlanga

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DEDICATION

This work is dedicated to my dearest parents who brought me to this world and gave me the gift of education.

ACKNOWLEDGEMENTS

Had there not been an encouragement and a contribution of many individuals and organizations, this dissertation would not have been completed. I am deeply indebted to them all .Hence, I would like to express my sincere gratitude to the following:

Firstly, I am deeply grateful to God for His wisdom and direction that has guided me throughout my life and this study.

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ABSTRACT

This study compared the effectiveness of natural and artificial hormones on growth performance (height) and root development of fruit tree cuttings in Bindura, Zimbabwe. Pre-treatments that were applied to select fruit tree cuttings included natural hormones namely honey, *aloe-Vera* , onion juice and banana peel powder(soaked for 5 minutes) , Artificial hormone in different concentrations namely gibberellic concentrations of 0,5mls and 0.7mls (soaked in 5 minutes) and Control with untreated fruit tree cuttings. A completely randomised design was used for this study. Black polythene pots were used for planting the pre-treated different fruit tree cuttings. Results obtained from this study showed the effectiveness of pre-treatments in fruit tree cuttings treated with Honey and *Aloe-Vera* was seventy five per cent (75%) in Avocado and Orange trees, gibberellic showed twenty per cent (20%) performance. This study showed that there is significant difference in performance of pre- treatments in growth and root development of fruit tree cuttings ($p < 0.05$). Results obtained from this study indicated that treating fruit tree cutting with aloe-Vera and honey produce good results in growth and root development. Nursery growth performance was measured in terms of height for a period of twelve weeks. Fruit tree cuttings subjected to Aloe-Vera juice recorded highest mean height over the period of twelve weeks. This study recommends *aloe-Vera* and honey (natural hormones) for growth performance and root development of fruit tree cuttings.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

ANOVA	Analysis Of Variance
BUSE	Bindura University OF Science Education
CM	Centimetres
FAO	Food and Agriculture Organisation
MM	Millimetres
SPSS	Statistical Package for the Software for Social Science
WHO	World Health Organisation
PGR	Plant Growth Regulators

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND TO THE STUDY

The global fruit industry has grown significantly in the later years due to rising consumer demand, year-round product availability, better breeds, and innovative production techniques (Clark and Finn, 2014). Sub-Saharan Africa is projected to experience significant growth in demand for fresh fruit on account of factors such as shifting dietary habits toward healthier and more sustainable diets, expanding rates of urbanization, and growth in the economy of the region and population (James and Zikankuba, 2017). Despite being less expensive and requiring less technical know-how, conventional tree breeding techniques are slow and uncertain in their results. Conventional cultivars are photoperiod-dependent and yield little. Consequently, the need for rapid multiplication of cultivated plants in Zimbabwe is an urgent step that must be taken to meet the growing demand for food. Natural and artificial hormones could be used to multiply plants at the time improving yield and enhancing biodiversity (Srivastava, 2002). These natural and synthetic hormones are plant growth regulators (PGRs) equivalents. In addition to mediating environmental stress with low concentrations of plant hormones, they can influence cell division, cell expansion, and cell structure and function.

Plant hormones are chemical signaling compounds that are generated at specific sites within the plant, but only in very small amounts. These hormones are naturally produced by the plant itself, though certain fungi and bacteria can also create very similar chemical compounds that can influence plant growth and development (Srivastava, 2002). According to (Mishra and Kumar, 2022) plant growth hormones are essential components that can control the overall outcome of plant growth and development. They have an impact on gene expression and transcription, as well as cellular division and growth (Hu et al, 1986). Plant growth regulators are synthetic plant substances that have been utilized in agriculture for a considerable period. The five major groups of PGR are auxins, gibberellins, cytokinins, abscisic acid, and ethylene (Day & Loveys, 1998). Also, a large number of related chemical compounds that function as hormones are synthesized in the laboratory. The majority of plant growth regulators can be utilized in large-scale commercial agriculture, involving horticulture and other agricultural farms. The specific growth stage of the parent plant (Day & Loveys, 1998), the timing of the cutting when it was harvested (Darwesh, 2000), and the

particular type of synthetic plant growth regulators that was applied (Rowzack, 2001), all influence cutting rooting success. Due to the high cost of synthetic PGRs and the risk of toxicity in plants, humans, and animals due to overdosing synthetic PGRs are being rapidly replaced natural alternatives (Cutler, 1990).

Natural plant extracts are abundant in various plant hormones and antioxidants that can be utilized to enhance, initiate, and actively promote the growth and development of other plant species. These plant growth hormones include auxin, gibberellins, and cytokinins, as well as natural growth inhibitors and regulators for example flavonols, abscisic acid, phenols and ethylene (Juanita, 1988). Because of their antibacterial properties and/or composition, natural hormones such as honey, aloe Vera, banana peels, and coconut water can be used to induce rooting process of stem cuttings as well as facilitate air layering technique of plants (Karunarathna and Kumuthini, 2016). However, written scientific evidence on the effect of is limited.

1.2 PROBLEM STATEMENT

Increasing global population, climate change, as well as increased nutritional demand, it is clear that the world will need to produce more food in the future. Naturally occurring plant hormones are less frequently utilized in place of artificial hormones and there is little knowledge on natural hormones or insufficient information on how to utilize them. Artificial hormones are very expensive, so it becomes difficult for people or poor rural people to buy and to plant trees. Natural hormones are less costly to obtain, can produce greater or longer-lasting responses, and are generally less prone to degradation (Clyawetal, 2003). Furthermore, propagation techniques like budding and grafting require specialized skills that farmers may not have. In that case, the production of low-quality fruits is a common occurrence and that discourages a lot of farmers. It would thus be worthwhile to improve fruit crop yield and quality through foliar application of plant hormones.

1.3 JUSTIFICATION

This study is focused on comparing growth performances of tree species using different artificial and natural hormones. Generally, from the researcher's knowledge, information on plant growth hormones is very scarce later alone how they compare. This study will therefore make information on the use of natural hormones for the growth performance of fruit trees

more widely available and accessible to the general public. Thus, the study will help cover the gap in information deficit among farmers in Bindura and the country. It will also help the farmers realize returns from fast growing trees that are highly productive and nutritious. Trees that are propagated through methods like grafting and budding are very expensive and requires a lot of specialized skill thus the use of plant growth hormones comes in handy at it is generally doable and inexpensive.

1.4 AIM

To assess nursery growth performance and root development of fruit tree cuttings treated with natural and artificial hormones at BUSE Nursery.

1.5 OBJECTIVES

1.5.1 To determine the most effective pre-treatment method for enhancing growth of fruit tree cuttings and root development

1.5.2 To compare the growth performance of fruit tree cuttings treated with different pre-treatment methods.

1.6 HYPOTHESES

1.6.1 There is no significant difference in performance among selected pre-treatment methods.

1.6.2 There is no significant difference in nursery growth performance of fruit tree cuttings among different hormones.

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CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

Successful production of fruit crops requires careful planning from the outset. Capital inputs like seedlings are high and for most of them, income cannot be expected for several seasons. This is associated with the shortage of specialized skills to train farmers on easy and affordable ways to propagate fast-growing trees. In recent years there has been an intensification of investment in general tree planting though not specifically on better methods of tree propagation. Due to this knowledge gap evidence suggests that the production gap between small-scale subsistence farming and large commercial agriculture has been consistently increasing over time. In addition, small-scale fruit tree production in rural and urban historically operated largely independent of comprehensive institutional support systems. As a result, these smaller-scale producers have faced restricted access to essential support services and limited opportunities to compete effectively within agricultural markets (Dhaese, 2001).

Tropical fruit trees are in general extremely heterozygous and have lengthy juvenile periods and that makes other processes like genetic improvement a slow process. There is, therefore, a great potential for increasing productivity by the use of plant growth hormones, once the control mechanisms involved are understood. Plant hormones occur entirely in plants and act at extremely low concentrations to promote or inhibit the growth of cells and tissues. They also cause the diversity of structures such as leaves, roots, or flowers and additionally, they control the reaction of the plant to environmental factors such as gravity. In the past propagation of fruit trees was commonly done through a seed which was a very slow process. Seed propagation cannot meet the current demand for fruit trees hence the need for fast-track propagation measures (Ghosh, 2000). Thus production of large amounts of planting material for tropical fruit trees has become increasingly important (Hiti-Bandaralage, 2017) . Of late, the use of plant growth hormones is a promising technique for seed germination and rooting (Suman, 2017). Fruit crops that are propagated asexually are easier to maintain their genetic purity (Bordolui, 2017)

2.2 TROPICAL FRUITS UNDER STUDY

2.2.1 MANGO

The mango tree (*Mangifera indica L.)* is a member of the *Anacardiaceae* family which is grown in a wide range of regions across the world (Bordolui, 2017). The foundational element of a prosperous fruit industry is the utilization of high-quality, healthy plant material. To increase mango production, farmers and breeders are searching for the simplest and least expensive methods of breeding. There is therefore a need for high-quality planting material and that requires more research. Currently, plant growth hormone that aids rooting of cuttings have been identified and the most commonly used in mangoes is IBA. The stem cuttings experience rooting when IBA is applied exogenously. IBA both multiplies the amount of roots and improves their growth. Auxin is a commercial application in cuttings and plays a function in rooting. The rooting percentage rose after the application of 2000 ppm IBA. IBA therapy improved the quality and quantity of roots in the injured area (Kumar, 2013).

2.2.2 CITRUS

It is believed citrus fruits originated from Southeast Asia and are a genus within the *Rutaceae* family (Roger, 2001). Oranges and other citrus fruits often have the highest concentration of vitamin C. They also have unique qualities like anti-inflammatory, anti-cancer, and antioxidant qualities that are vital to human health. When it comes to producing citrus fruit, vegetative methods are preferred over sexual propagation because they offer several benefits, such as true to type and the ability to produce a large number of new plants in a small area from a small number of stock plants. According to (Dawa, 2013), rootstocks grown through vegetative reproduction develop longer and more roots. Plant growth hormones enable the simple, quick, economical, and modest propagation of cuttings (Dawa, 2013).

2.2.3 GUAVA

The delightful fruit guava (*Psidium Guajava* L.) is a member of the *Myrtaceae* family (Rashad, 2018). According to (Rashad, 2018), this fruit is perfect for ensuring nutritional security and is a resilient plant. Originating in tropical America, it is grown in both subtropical and tropical climates. It has a high pectin, mineral, and vitamin C content. The fruit has a high ascorbic acid content and is a prolific bearer (Nitin, 2016).It can withstand drought conditions and has a wide range of adaptability and year-round fruiting potential. According to (Pereira, 2017), there are two methods for propagation by cuttings which include root cutting and shoot cutting. The

cuttings ought to come from a robust, flexible plant. To encourage roots, the cuttings must be treated with plant growth regulators.

2.3 PLANT GROWTH HORMONES

Plant hormones can be classified into five groups based on their chemical structures and the specific responses they elicit within the plant. (Kobayakawa, 2017), Cells have to be competent to perceive the chemical to respond to a hormone, for some cells the lack of capacity to recognize the hormone reduces their ability to respond.

The hormones utilized in plant propagation can either be naturally occurring or synthetic to mimic the structure and effects of naturally occurring plant hormones (Westwood, 2003). The commonly used hormones are naturally occurring because they are less costly to obtain, resulting in less or more prolonged lasting responses, and can be less prone to degradation within the plant and during storage. Naturally produced plant hormones can be categorized into five main groups' auxin, cytokinin, gibberellin, abscisic acid, and ethylene (Weiner, 2010). These naturally occurring plant hormones are also present in artificially produced plant growth regulators. In particular, there are artificially produced variants of cytokinin, ethylene, and auxin hormones (Kobayakawa, 2017). While the chemical structures of these artificial auxin and cytokinin compounds may not be identical to the natural plant hormones, they have similar effects on the plant (Walsh, 2003).

2.4 ROLES OF SPECIFIC PLANT GROWTH HORMONES

There are five main classes of plant growth regulators used in plant cell culture and their full description is found below.

2.4.1 AUXINS

Auxins are compounds that positively influence cell enlargement, bud formation, and root initiation (Maji, 2002). They also promote the production of other hormones and in conjunction with cytokinins, they control the growth of stems, roots, flowers and fruits (Daphne, 2005). IAA, IBA and 2, 4-dichlorophenoxy acetic acid (2, 4-D) as well as pictogram are often added to nutrient media. According to (Pierik, 1987), the naturally occurring auxin, IAA, is generally added in a concentration of 0.001 to 10 mg/ml for better results.

2.4.2 CYTOKININS

Cytokinins are regularly used to stimulate growth and development. The common ones are zeatin, kinetin, BAP, 2, P, and 2-Isopentenyladenine (2iP (Slater, 2005). They usually promote cell division, especially if added together with an auxin. In high concentrations (1 to 10 mg/ml), they can induce adventitious shoot formation, but root formation is generally inhibited. They promote auxiliary shoot formation by decreasing apical dormancy- a condition where vertical growth supersedes lateral growth in a plant (Slater, 2005).

2.4.3 GIBBERELLIC ACID

Gibberellic acid is the commonly used hormone though it is very vital to bear in mind that it is heat sensitive hence after autoclaving, 90% of its biological activity is lost (Pierik, 1987). In general, gibberellins induce elongation of internodes and the growth of plants or buds *in vitro*. They also break the dormancy of isolated embryos or seeds. Gibberellins usually inhibit adventitious root formation as well as adventitious shoot formation (Slater, 2005).

2.4.4 ABSCISIC ACID

Abscisic acid (ABA) is most commonly utilized in plant tissue culture to stimulate distinct developmental processes for example somatic embryogenesis (Kuzyakov, 2019). It is composed of one chemical compound normally produced in the leaves of plants, originating from chloroplast when plants are stressed (Tsai, 1997). It acts as an inhibitory chemical compound that affects bud growth, seed, and bud dormancy (Else, 2001). In plant species from temperate parts of the world, it plays a role in leaf and seed dormancy by inhibiting growth.

2.4.5 ETHYLENE

Ethylene is a naturally occurring plant growth regulator that occurs in gaseous form (Clyawetal, 2003). It is most commonly associated with controlling fruit ripening though its utilization in plant tissue culture is not as common (Clyawetal, 2003). However, ethylene presents a particular challenge for plant tissue culture. Certain plant cell cultures generate ethylene, and if its levels accumulate significantly, it can inhibit the growth and development of the culture. The type of culture vessel utilized and its method of closure affect the gaseous exchange between the culture vessel and the outside environment which in turn influences the levels of ethylene present within the culture.

2.5 SOURCES OF HORMONES

2.5.1 HONEY

According to Sanderson 2013, state that just 1 tablespoon (15 ml.) of honey contains approximately 64 calories and 17 grams of carbohydrates, primarily in the form of sugars most of which come from sugars. Honey appears to provide plants with a significant boost. Honey's antibacterial and antifungal qualities are the reason it works well as a natural rooting hormone. Using honey to protect plant cuttings from dangerous infections enhances the ability of the cutting's natural rooting plant hormones to promote and sustain root growth. Certain plant species can successfully root without the assistance of additional rooting hormones, but other plant species might need the extra help that natural substances like honey can offer to root and establish themselves.

According to (Firth, 2017), honey contains natural compounds that can act like rooting hormones, helping to stimulate the growth of new roots on the cutting. While the exact compounds in honey that stimulate root growth in plant cuttings have not been fully identified, several studies have suggested that honey contains a variety of compounds such as enzymes, sugars, and vitamins that may play a role in promoting root growth. The properties of honey help Improve moisture retention. Honey is hygroscopic, meaning it absorbs moisture, which helps retain moisture on the cut end of the cutting, which is important for the development of new roots.

According to (Ratiha, 2012), honey is a supersaturated solution of mainly sugars, with more than 70% sugars and less than 20% water. The sugars make up about 95% of the dry weight of honey. The main sugars are the monosaccharides fructose and glucos**e** which are the most abundant at 70% of total sugars, along with the disaccharide sucrose, made of glucose and fructose joined together) which we normally call ‘sugar’. It also contains small quantities of oligosaccharides, which are types of sugars that are comprised of short chains of monosaccharides. Studies have shown that apart from plant hormones, another main factor promoting rooting formation is sucrose (Aboel, 2002), and that oligosaccharides deposited in the cell wall of plants induce root formation and growth (Mehrabani, 2016).

There are several vitamins present in honey, such as Vitamin C and Vitamin B1 (thiamine) which were found to help with the initiation of root in cuttings in many plants (Turetskaya,

1968). It has been known for a while that vitamins are the promoter of root-forming factors in several plant species (Chee, 1995).

2.5.2 BANANA PEEL POWDER

Bananas can stimulate root growth in plants. Banana peels, in particular, contain calcium which is known to promote root growth and help add oxygen to the soil. Additionally, banana peels also contain magnesium which assists with photosynthesis, a crucial process for plant growth. Furthermore, the sulfur present in the banana peels helps plants develop strong roots and repel pests. When used as a fertilizer or added to compost, banana peels can provide these nutrients to your plants and help stimulate root growth. Bananas are a rich source of vital nutrients and minerals that can help stimulate and support root development in plants. The plant hormones ethylene and auxin found in bananas can trigger and encourage root formation when applied to plant cuttings or seedlings

The potassium content in bananas also aids specifically in the formation of healthy, robust root systems, while also promoting overall plant growth. Additionally, banana peels contain beneficial bacteria that can provide supplementary nutrition to the soil when placed around the plant. The potassium present in bananas helps directly stimulate root growth, making it easier for the plant to establish a strong root system. Furthermore, the sugars present in banana peels are beneficial for the soil, helping to maintain moisture levels and supply vital nutrients to support vigorous plant growth.

2.5.*3ALOE VERA*

Aloe Vera is an effective natural rooting stimulant for plant cuttings due to its antibacterial and antifungal properties that protect the cuttings from pathogens. These protective qualities help shield the cuttings from harmful pathogens, allowing inherent growth hormones already present in the cuttings to effectively stimulate and promote root development. According to (Kelly, 2021), *Aloe Vera* contains an abundant variety of beneficial nutrients including vitamins, minerals, amino acids, and enzymes that are helpful for further supporting and enhancing root growth. It contains around 75 potentially active components, one of which is salicylic acid (SA) which has antibacterial properties. So, by dipping the cutting in *Aloe Vera* gel you can kill off harmful bacteria and fungus, thereby increasing the chances of cuttings successfully taking root and establishing growth.

2.5.3 PURPLE ONION

Onions provide a variety of nutrients, notably vitamin C, potassium, manganese, little calcium; iron, magnesium, selenium, and minerals which can promote root growth. Onion juice is said to contain auxins which promote cell division and elongation which is a debate to be proven with the results.

CHAPTER 3: MATERIALS AND METHODS

3.1 DESCRIPTION OF THE STUDY AREA

This study was carried out in Bindura town (17°18'S, 31°20'E, altitude of 1100 m). The town is 89 km north of Harare Mazoe valley (Figure 1).The vegetation around Bindura is a typical miombo woodlands dominated by *Brachystegia (B. spiciformis* and *B. boemmii)* and *gunuses* of *Julbernadia globiflora*. Dominant grasses are *Hyperrhenia filipendula, H. dissolute and Hyperthelia dissolute.* The soils of the area have a good nutrient content that support the growth of fruit trees. Bindura district falls under agro-ecological region IIb, which receives rainfall ranging from 750 to 1200 mm per annum (Mugandani, 2012).

Figure 3.1: A map showing Astra campus Nursery at Bindura University of Science Education, Zimbabwe.

3.2 EXPERIMENTAL DESIGN

The research used an experimental research design to study the cause and effect relationship the research variables. Researchers manipulate one variable and observe the effects on another variable (Creswell, 2014). In this case the study added artificial and natural hormones to see the performance of cuttings over time.

3.3 METHODS OF DATA COLLECTION

The cuttings used for the study were collected from BUSE orchard. A total of 20 cutting from each sample tree were collected giving a total of 140 cuttings. The cuttings were collected 19nth of December 2023 and they were all collected on the same day. For each tree, all cuttings were cut to the same length and almost the same circumference.

3.4 TREATMENTS

The experiment used four different types of fruits trees that is mango, orange, guava and avocado. The cuttings were treated with 6 different hormones that is honey, *aloe-Vera,* gibberellic acid, and banana peel powder and onion juice. Note that gibberellic acid was used twice at different concentration that is 0.5mls and 0.7mls making a total of 6 treatments, all cuttings were ring barked. The experiments used a Complete Randomized Block Design (CRDB). The experiment 5 cuttings from each tree species they were all dipped into each of the six treatments (honey, *aloe-Vera,* gibberellic acid 0.5mls, gibberellic acid 0.7mls, and banana peel powder and onion juice) once for five minutes and the process was replicated three times before planting. The 5 cuttings from each fruit tree type were planted into medium sized polythene bags covered with plastics. The result was each polythene bag contained 5 treated cuttings from the same fruit tree. Control, five cuttings from tree was planted without any treatment planted into medium sized polythene bags. Each polythene bag contained 5 cuttings from the same tree species. All sown in polythene bags were randomly placed in the nursery to avoid pest and disease spread. The cuttings were observed fortnightly through the study period.

3.5 MEASUREMENTS

The cuttings were watered fortnightly and the observed parameters included, development of shoots, wilting and rooting. Root length and shoot height were measured after three months of

the experimental method. Cuttings were randomly selected from different treatments and control fortnightly for the assessment. The selected cuttings were carefully uprooted and placed in a wide, flat bowl filled with as this allowed the soil around the roots to be washed off diligently with .water and the polythene bags were carefully cut. The uprooted cuttings were then separated into their root and shoot components. Each of these components of the cuttings was placed into its own labelled envelope for ease of identification and further analysis

3.6 METHODS OF DATA ANALYSIS

Data collected in the experiments were analyzed using one-way analysis of variance (ANOVA) in SPSS Version 17.0.

CHAPTER 4: RESULTS

4.1 EFFECTIVENESS OF DIFFERENT PRE-TREATMENT METHODS ON GROWTH AND ROOT DEVELOPMENT OF FRUIT TREE CUTTINGS

4.1.1 ROOT AND SHOOT DEVELOPMENT OF FRUIT TREES

The development of the roots in experimental fruit trees is shown in Table 4.1. The significantly highest root length was recorded on the Avocado trees (5.53±0.09cm) under the Honey treatment, whereas the significantly lowest length was for the Mango trees (2.83±0.18cm) in the Control treatment. The Honey treatment was significantly different from other treatments in Avocado trees root length ($p < 0.05$). Also, the Honey juice treatment recorded the significantly highest root lengths for the Guava trees (4.10±0.17cm) and Mango trees (5.19±2.05cm). In addition, the two Gibberellic acids were significantly different in Guava tree root length ($p < 0.05$). While the Banana peel powder recorded the highest root length for the Orange trees (4.60±0.49cm). Overall, the efficiency of the treatments in promoting root development in experimental fruit trees followed the sequence Honey > Banana peel powder > *Aloe Vera* juice > Onion juice > Gibberellic 0.5ml > Control > Gibberellic 0.7ml.

Table 4.1: Length of roots in trees under different treatments (mean±S.D.).

Fruit tree	Avocado	Orange	Guava	Mango
Aloe Vera juice	4.00 ± 0.21^{a}	4.43 ± 0.20^{a}	4.60 ± 0.26^{a}	5.10 ± 2.13^{a}
Honey	$5.53.\pm0.09^{a}$	4.50 ± 0.36^{a}	4.10 ± 0.17^{b}	5.19 ± 2.05^{a}
Banana peel powder	5.30 ± 0.12^{b}	4.60 ± 0.49^{a}	4.50 ± 0.47^{a}	4.73 ± 0.37^{a}
Onion juice	3.80 ± 0.57^{a}	4.03 ± 0.59^{a}	4.40 ± 0.15^{a}	3.67 ± 0.09^{b}
Gibberellic acid 0.5ml	3.57 ± 0.15^{c}	3.83 ± 0.18^{b}	3.87 ± 0.48^{c}	3.33 ± 0.15^{b}
Gibberellic acid 0.7ml	4.00 ± 0.41^{a}	3.83 ± 0.45^{b}	3.70 ± 0.20^{c}	3.37 ± 0.23^{b}
Control	3.37 ± 0.22^{c}	4.00 ± 0.12^{a}	3.67 ± 0.12^{c}	2.83 ± 0.18^{d}

Different [a, b, c, d, e] superscripts down a given column shows significantly different means ($p<0.05$)

While, the highest shoot length was observed in the Avocado trees (5.60±0.10cm) under the *Aloe Vera* juice treatment (Table 4.2). In addition, the *Aloe Vera* significantly increased tree shoots attaining highest values in other fruit trees, that is, Guava trees (4.53±0.20cm), and Mango trees (4.73±0.23cm). However, for the Orange trees, the *Aloe Vera* juice and Honey there was no significant difference ($p > 0.05$) and attained the same value of 4.43±0.20cm. The Control treatment displayed the minimum values in shoot length in all the fruit trees, and was significantly different from other treatments p value less than 0.05. Efficiency of the treatments in promoting shoot length decreased in the order *Aloe Vera* juice > honey juice > gibberellic acid 0.5ml > banana peel powder > onion juice > gibberellic acid 0.7ml.

Table 4.2: Length of shoots in trees under different treatments (mean±S.D.).

Fruit tree	Avocado	Orange	Guava	Mango
Aloe Vera juice	$5.60±0.10^{a}$	$3.87±0.15^{a}$	$4.53±0.20^{a}$	$4.73±0.23^{a}$
Honey	$4.13±0.15^{b}$	$3.87±0.19^{a}$	$3.83±0.03^{b}$	$3.70±0.23^{b}$
Banana peel powder	$3.30±0.15^{c}$	$2.67±0.19^{b}$	$3.27±0.15^{b}$	$2.47±0.18^{c}$
Onion juice	$2.83±0.38^{d}$	$2.87±0.12^{b}$	$2.50±0.17^{c}$	$2.27±0.22^{c}$
Gibberellic acid 0.5ml	$3.77±0.33^{c}$	$3.00±0.36^{b}$	$3.00±0.29^{b}$	$3.13±0.29^{b}$
Gibberellic acid 1.5ml	$2.37±0.22^{d}$	$2.27±0.15^{c}$	$2.20±0.21^{c}$	$2.70±0.15^{c}$
Control	$0.80±0.29^{e}$	$0.90±0.12^{d}$	$0.50±0.00^{d}$	$0.63±0.09^{d}$

Different [a, b, c, d, e] superscript down a given column denotes significantly different means p value less than 0.05. ($p<0.05$)

4.2 GROWTH PERFORMANCE OF FRUIT TREES UNDER DIFFERENT TREATMENTS

The growth performance of four fruit trees with respect to different treatments is shown in Figure 4.1 to Figure 4.4. For the avocado trees, the most significant treatments were *Aloe Vera* juice and Honey juice which yielded maximum height of 26.8±1.3 cm 22.7±1.1 cm respectively

after 12 weeks (Figure 4.1). The Control treatment attained the lowest height of 9.4±1.5 cm. in addition, there were no significant differences in the other treatments ($p > 0.05$).

For the Orange trees, the Honey treatment was the significantly effective treating attaining a height of 19.3±1.8 cm followed *by Aloe Vera* juice with a height of 16.5±0.9 cm by week 12 of the experiment (Figure 4.2). In addition, the Banana peel powder and the Gibberellic acid 0.5ml were not significantly different ($p > 0.05$), whereas the Onion juice and the Gibberellic acid 0.7ml were not significantly different ($p > 0.05$). The Control treatment had the lowest height of 8.1±1.1 cm.

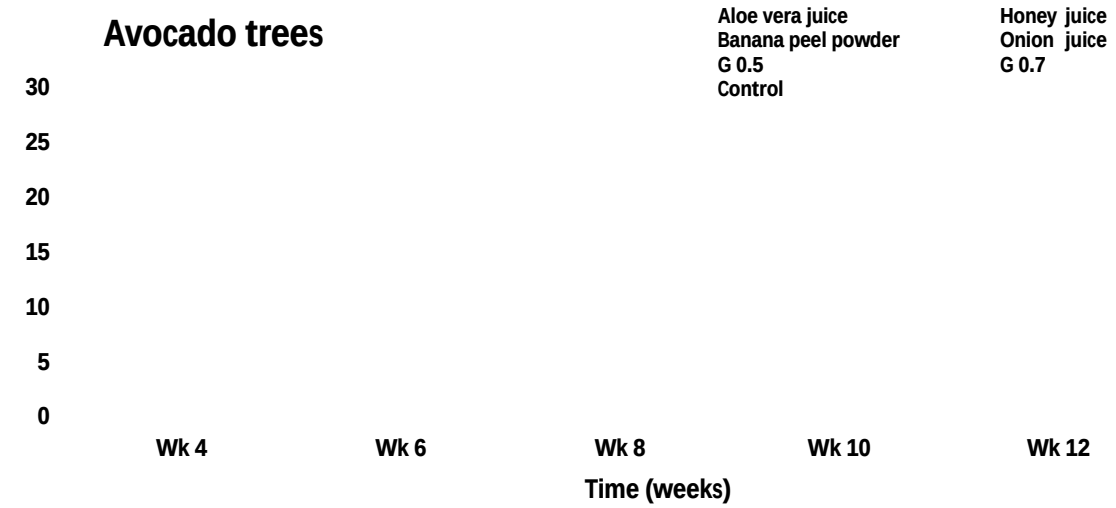

Figure 4.1: Avocado trees growth performance under different treatments

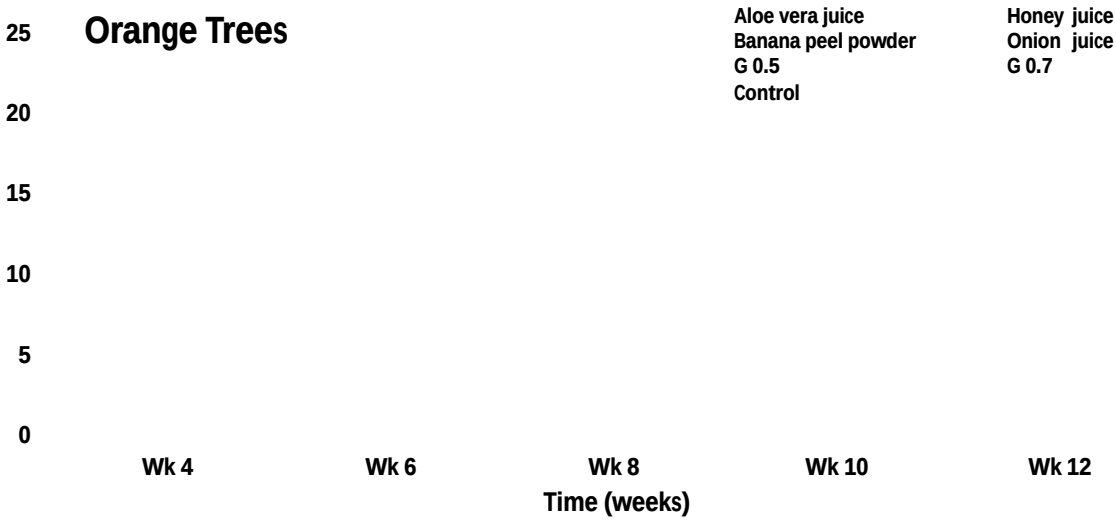

Figure 4.2: Orange trees growth performance under different treatments

In Figure 4.3 the Honey juice (19.2±2.1 cm) and Aloe Vera (18.1±1.9 cm) treatments were the most effective treatments after 12 weeks and were significantly different from other treatments p – value less than 0.05 ($p < 0.05$). The Onion and Banana peel powder were not significantly different ($p > 0.05$) whereas the two gibberellic treatments were also not significantly different ($p > 0.05$). The Control treatment (7.2±1.5 cm) had the significantly lowest height after 12 weeks.

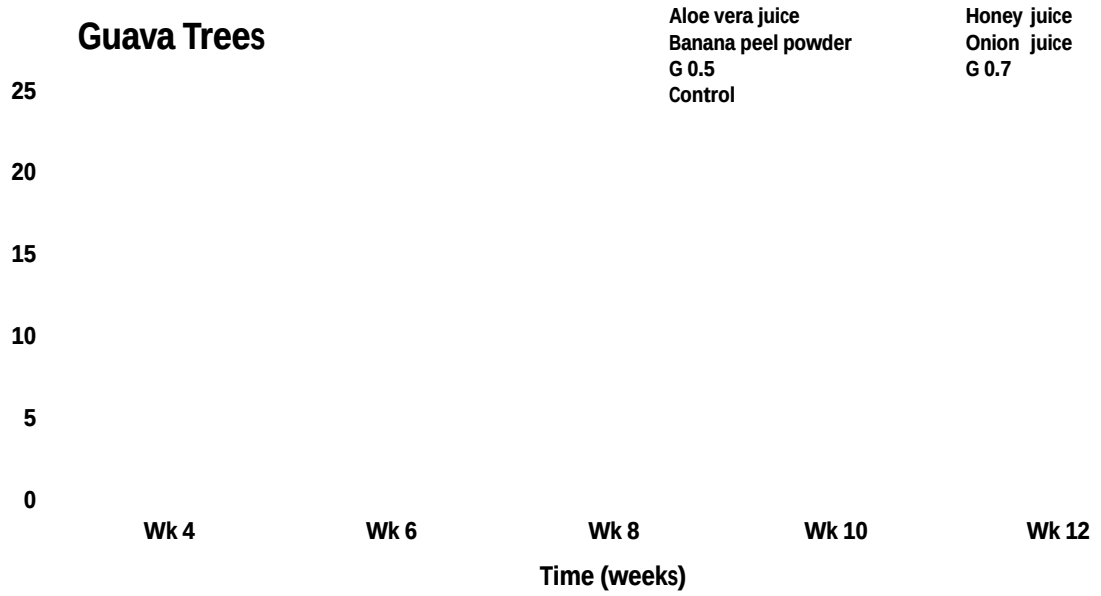

Figure 4.3: Guava trees growth performance under different treatments

The *Aloe Vera* juice and the Honey were the most effective treatments reaching heights of 22.5±1.6 cm and 21.3±1.3 cm respectively by the 12th week of the experiment. On the other hand, the Control (13.3±1.1cm) was the least effective treatment (Figure 4.4).

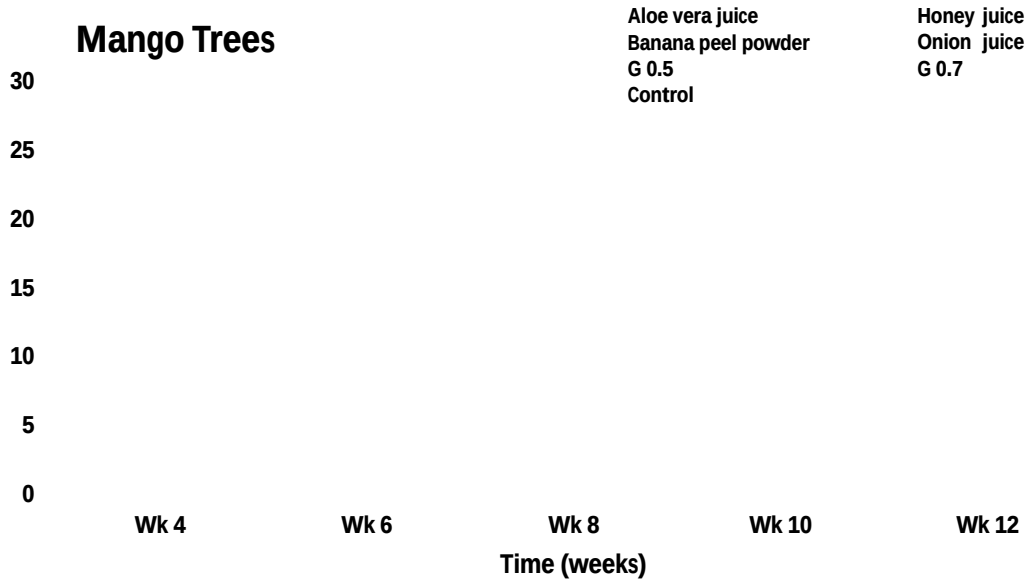

Figure 4.4: Mango trees growth performance under different treatments

CHAPTER 5: DISCUSSIONS

5.1 EFFECTIVENESS OF DIFFERENT PRE-TREATMENT METHODS ON GROWTH AND ROOT DEVELOPMENT OF FRUIT TREE CUTTINGS

5.1.1 ROOT AND SHOOT DEVELOPMENT OF FRUIT TREES

The results of the study recorded the highest root length on the Avocado cuttings treated with honey water compared to all the other trees. Avocado trees seem to be responding well to honey water in terms of root development. The outcomes of the study align with (Smith, 1996) who compared honey versus sugar in the rooting of avocado cuttings and the plants treated with honey had the highest number of roots. According to (Smith, 1996), honey is composed of a variety of minerals, amino acids, sugars, antioxidants and glycolic acid. The antibacterial and antifungal properties in honey provide it with robust anti-microbial properties. These protective qualities can help prevent root rot and maintain a cleaner environment that is conducive to healthy root rot development in plant cuttings which can help prevent root rot and maintain a cleaner environment conducive to root growth in plant cuttings. The antimicrobial nature of honey represents a safe, cost effective, and easy to use method to promote the development of adventitious roots in plant. The beneficial properties of honey can create conditions that support the growth of healthy roots, making it a potentially valuable natural rooting aid for propagating plants from cuttings. On the same note, honey was employed by (Dunsin, 2018) as a substitute hormone in an experiment on *Parkia biglobos*a. Compared to the untreated control cuttings, the honey-treated cuttings had a higher total number of roots, a longer total root length, and a reduced mortality rate.

The study noted that banana peel powder recorded the highest root length for the orange trees. According to (Fatkhan, 2020) , stated that in their study of banana peels effects on different citrus tree species found out that banana peel powder significantly affected the number of roots by giving the highest number of root length parallel to the control and cinnamon treatment.

The results of the study showed that cuttings treated with *aloe Vera* had the longest shoot length compared to those treated with either honey, banana peel and onion juice. Similar results have been observed by (Jan, 2015) in olive cuttings where the length of leaves was found to increase

in grape cuttings that were treated with *aloe Vera* gel. This positive outcome is likely because *Aloe Vera* contains a variety of essential vitamins macronutrients, gibberellins, salicylic acid, and micronutrients which promote an effect on plant growth and development. Furthermore, *Aloe Ver*a gel is also known to contain IAA (Indole-3- acetic acid) which is a naturally occurring auxin that can act as an alternative growth plant hormone (Uddin, 2020), comparable findings by (Hamouda, 2012). According to (Mishra and Kumar, 2022)natural extracts from the leaves of *Aloe Vera* plants are considered alternative compounds rich with natural plant hormones, which can be used as growth enhancers.

5.2 GROWTH PERFORMANCE OF FRUIT TREES UNDER DIFFERENT TREATMENTS

The significant difference between the other treatments and the control on plant height plant shows that plant growth hormones have a crucial role in plant metabolism. (Muojekwu, 2017), reported that rooting compounds, whether in liquid or powdered foam when effectively applied to aid the rooting process in species that are moderate to highly difficult to root. These rooting hormones can accelerate root initiation of root formation, improve the uniformity of rooting across the cuttings, increase the total number of roots produced, and ultimately reduce shrink and rooting time.

In general, the results show that the best-performing treatment in enhancing plant growth was *aloe Vera* and honey juice across all four fruits. The results align with the observation by (Heba, 2023) who found out that *Aloe Vera* extract treatment gave a greater effect size for root branching (secondary roots) and height of seedlings, which may be attributed to the presence of bio-stimulants and other plant nutrients. The results by (Hamouda, 2012) also confirm the findings of this study, found that plant height as a growth character was influenced by Aloe Vera extract at different rates, and the plants were elongated in comparison with the control. According to (Sherif, 2017)**,** ***aloe Vera*** extract has sugars, enzymes, vitamins, amino acids, minerals, plant sterols, gibberellins, and salicylic acid. These nutrients are linked to improvements in plant growth, oil production, and mineral composition. Numerous components of this plant extract have been identified to influence nutrient absorption characteristics or root growth, which may have an impact on the root development of cuttings, even though the exact mechanisms of action of the extract remain unknown.

According to (Ahkami, 2009)stated that it has been demonstrated that *aloe Vera* sugars, when added to the rooting medium, promote roots in cuttings by giving the plant a carbon source. Amino acids have also been connected, through chelation, to higher nutritional intake. *Aloe Vera* extract also includes hormone-like chemicals that may aid in growth and development, such as salicylic acid, the rooting hormone (Sherif, 2017).

While honey performed well in promoting plant height in this study several studies prove that honey is more of a rooting rather than an elongating hormone. According to (Ibironke and Victor, 2016), honey can be beneficial for root growth and maintaining vigor and health. This is because honey exhibits antifungal and antiseptic properties suggesting it has the potential to be used as a natural rooting hormone as bee honey contains enzymes that can promote root development in plants. Furthermore, results of a study by (Heba, 2023) demonstrate that in comparison to the two synthetic plant hormones utilized and the natural extracts—except cinnamon and honey, which had the lowest values of shoot length in the two seasons—the majority of treatments of natural plant extracts at all rates had a substantial impact on shoot length.

The results of the study also showed that there were no significant differences between the other natural growth hormones and the artificial ones (onion juice, banana peel, gibberellin acid 0.5, and gibberellin acid 0.7). According to (Nelson, 2016), gibberellin may not perform well as a growth enhancer since they are important in breaking seed dormancy (in contrast to ABA), inducing flowering, stimulating pollen tube formation, and stimulating fruit development. However, (Hedden, 2015)states gibberellin can also stimulate cell division and foster elongation, thus explaining the symptoms of the “foolish seedling disease.” The study's findings indicate that other natural plant extracts, like honey and *aloe Vera*, have a promising impact on vegetative propagation. Because of their advantages, affordability, and environmental safety, these extracts can be suggested as substitutes for chemicals that induce root formation and promote growth.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.0 CONCLUSIONS

According to the results of this study, it can be concluded that suggest that other alternative natural plant extracts, like honey and aloe, have a promising impact on vegetative propagation. Because of their advantages, affordability, and environmental safety, these extracts can be suggested as substitutes for chemicals that induce root formation and promote growth.

6.1 RECOMMENDATIONS

6.1.1 The study recommends that natural growth hormones be adopted for large-scale treatment of cuttings with less cost as some of them like *aloe Vera* can be grown and have a significant effect on the overall growth of cuttings.

6.1.2 The study also recommends that farmers adopt the use of natural growth hormones, as they can be a cost-effective and environmentally friendly alternative to synthetic plant growth regulators and phytohormones.

6.1.3 The author also recommends further studies into the use of onion juice as a plant growth hormone

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APPENDICES

APPENDIX 1: SPSS OUTPUT FOR SHOOTS

Report

Code		Avocado	Orange	Guava	Mango
Aloe Vera juice	Mean	5.6000	3.8667	4.5333	4.7333
	Std. Error of Mean	.10000	.14530	.20276	.23333
Honey	Mean	4.1333	3.8667	3.8333	3.7000
	Std. Error of Mean	.14530	.18559	.03333	.23094
Banana peel powder	Mean	3.3000	2.6667	3.2667	2.4667
	Std. Error of Mean	.15275	.08819	.14530	.17638
Onion juice	Mean	2.8333	2.8667	2.5000	2.2667
	Std. Error of Mean	.17638	.12019	.17321	.21858
G 0.5	Mean	3.7667	3.0000	3.0000	3.1333
	Std. Error of Mean	.03333	.36056	.28868	.29059
G 0.7	Mean	2.3667	2.2667	2.2000	2.7000
	Std. Error of Mean	.21858	.14530	.20817	.15275
Control	Mean	.8000	.9000	.5000	.6333
	Std. Error of Mean	.28868	.11547	.00000	.08819
Total	Mean	3.2571	2.7762	2.8333	2.8048

Std. Error of Mean	.31582	.21897	.27389	.27207

APPENDIX 2: SPSS OUTPUT FOR ROOTS

Report

Code		Avo	Ora	Gua	Man
Aloe vera juice	Mean	4.0000	4.4333	4.6000	5.1008
	Std. Error of Mean	.20817	.20276	.26458	.71931
Honey	Mean	4.1000	4.5000	5.5333	5.1857
	Std. Error of Mean	.17321	.36056	.08819	2.05445
Banana peel powder	Mean	5.3333	4.6000	4.5000	4.7333
	Std. Error of Mean	.12019	.49329	.47258	.36667
Onion juice	Mean	3.8000	4.0333	4.4000	3.6667
	Std. Error of Mean	.56862	.58973	.15275	.08819
G 0.5	Mean	3.5667	3.8333	3.8667	3.3333
	Std. Error of Mean	.14530	.17638	.48074	.14530
G 0.7	Mean	4.0000	3.8333	3.7000	2.8333
	Std. Error of Mean	.40415	.44845	.20000	.17638
Control	Mean	3.3667	4.0000	3.6667	3.3667

	Std. Error of Mean	.21858	.11547	.12019	.23333
	Mean	4.0238	4.1762	4.3238	4.0314
Total	Std. Error of Mean	.16255	.13765	.16531	.33210