BINDURA UNIVERSITY OF SCIENCE EDUCATION

DEPARTMENT OF CROP SCIENCE

EFFECTS OF ADOPTING ALOE-VERA AS A ROOT HORMONE IN PROPAGATION OF GRANADILLA CUTTINGS UNDER HYDROPONICS AND IN A SOIL BASED SYSTEM.

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS OF THE BACHELOR AGRICULTURE SCIENCE HONOURS DEGREE IN (CROP SCIENCE)

JUNE 2023

DECLARATION

I NGWENYA GRACE T do hereby declare that this dissertation was the result of my own original efforts and investigations, and such work has not been presented elsewhere for any degree or any university programme. All other supplementary sources of information have been acknowledged by means of references.

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CERTIFICATION OF THE DISSERTATION

Bindura University of Science Education

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The undersigned certify that they have read and recommend to the Bindura University to accept a dissertation entitled: **EFFECTS OF ADOPTING ALOE-VERA AS A ROOT HORMONE IN PROPAGATION OF GRANADILLA CUTTINGS UNDER HYDROPONICS AND IN A SOIL BASED SYSTEM.**

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In partial fulfilment of the requirements for the Bachelor of Science Honors Degree in Crop Science.

SUPERVISOR..

DATE ....

Dedication

I dedicate this research to my father Jerry Ngwenya and my sister Elizabeth Ngwenya who supported me when I needed help during this study. These two were there to give me encouragement in hard times, they supported me with financial support.

Acknowledgements

I give all the glory to the Lord who has taken me this far, for it is not by my power but His grace. I would like to express my gratitude to my supervisors Ms Kamota and Dr. T. J. Chikuvire who helped me with advisory assistance in supplying the technical advice in support of this study. My special thanks extend to Prof. R Mandumbu who helped me in data analysis and interpretation. My gratitude extend to Mr S Gomba for his help during my experiment and for giving me the materials and land I used in this research. My father I salute you for your support in every stage during my research.

Abstract

The study was conducted at Allenby farm to investigate the effects of adopting aloe vera as a rooting hormone in granadilla propagation under hydroponic and soil-based systems. The study sought to ascertain the impacts of aloe vera on root number and shoot number development rate on granadilla cuttings under hydroponics as well as in soil-based systems. The experiment was designed as a randomized complete block design (RCBD) 2*2 factorial experiment. The treatments were replicated 3 times. Two factors were media (soil and water) and rooting hormone (aloe vera 100ml and no aloe vera). The center of the aloe vera plant is packed with aloe vera gel, which is mainly salicylic acid. Salicylic acid is a naturally occurring anti-inflammatory chemical that is directly responsible for root stimulation in a cutting. The total number of treatments was four. Fifteen cuttings were put in each container and tire. There was a significant difference ($p<0.001$) between granadilla cuttings treated with aloe vera and those without. Hydroponics with aloe vera showed the highest root number of 8.67 and the highest shoot number of 6 at week 6. Since aloe vera proved to have an effect in propagating granadilla cuttings farmers can adopt the use of aloe vera as a rooting hormone to increase rooting and shooting in cuttings. According to this research, hydroponics can be adopted as a good medium for propagating granadilla cuttings since it showed high rooting and shooting of granadillas.

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List of Acronyms and abbreviations

IBA -Indole-3-Butyric Acid

GA -Gibberellic Acid

SB - Soil Based

H - Hydroponics

TA - With Aloe vera

TNA - No Aloe vera

KG - Kilograms

L - Liters

IAA -Indole Acetic Acid

USD - United States Dollar

G -Grams

RCBD -Randomized Complete Block Design

ANOVA -Analysis of Variance

CHAPTER ONE

1.0 Introduction

1.1 Background

The granadilla species is cultivated in the tropics for its high-quality fruit, therapeutic properties, and decorative value. These species reproduce by seed, however due to a combination of physical and physiological dormancy, seed germination is low and irregular (Pendota, sc et al., 2017). As Santso and Parwota (2014) point out, vegetative methods using cuttings are always preferred over seed propagation due to the difficulty of germination. This is to produce a faithful type of early fruiting plant that produces fruit of uniform quality.

The problem with using cuttings is slow root development, therefore plant growth regulators such as auxin have been used to boost the percentage of roots in cuttings and increase the number of roots per cutting for rapid root inoculation (Garande et al., 2002). However, there are other organic growth hormones. The best option is to replace the auxin with a natural root-enhancing substance that is free and safe to use. Natural rooting hormones are an environmentally friendly alternative to plant growth hormones that are sythetic such as IBA (El-Sherif et al., 2017).

Aloe Vera is one of the most common root hormones used in plant propagation. Aloe vera has been used as a rooting hormone in grape propagation (Rakibuzzaman et al., 2019). Aloe vera has been used as a biostimulant to increase growth and yield in Abelmoschus es cultus (Padmajaya et al., 2007). Additionally, many basil cultivars have been treated with aloe vera and some plant extracts as biofertilizers for growth and yield (Ahmed et al., 2014). Jamal Uddin et al. (2020) studied the effects of natural chemicals on vine cuttings against synthetic hormones. The Aloe vera gel treatment produced the largest root length (12.9 cm), followed by IBA (10.9 cm), while the control treatment produced the smallest root length (5.2 cm). He came to the conclusion that aloe vera gel was the greatest natural ingredient that might be used as a possible rooting hormone substitute for synthetic rooting hormones in grapevine propagation. Siddiqui et al. (2019) investigated the quantity of main and secondary roots in Vitex diversifolia following treatment with IBA, aloe vera, coconut water, or a combination of aloe vera and coconut water andconcluded that aloe vera had more main roots than coconut water.

According to El-Sherif, (2017) aloe vera contains lAA and could be used as an alternative root hormone. Supporting the use of Aloe vera as a rooting hormone, Sahu (2013) states that Aloe vera contains gibberylline and salicylic acid that promote plant growth. Basing on the previous studies of aloe vera as a root hormone, it is imperative to explore the effects of adopting it as a root hormone specifically in propagation of granadilla cuttings under hydroponics as well as in a soil based system.

To increase the efficiency of water, root hormones, and fertilizer consumption, hydroponic system technology has been integrated into horticulture production (Gorbe and Calatayud, 2010; Urrestarazu, 2013; Van Kooten et al., 2004). Many organic rooting components, such as aloe vera, and their advantages have been highlighted in many studies where they were employed on other plants, such as apples, rather than granadilla. The researcher will focus specifically on aloe vera effects on granadilla rooting and shooting in soil and hydroponics system.

1.2 Problem statement

As the export market for granadilla expands, other propagation methods need to be thoroughly investigated to produce large quantities of granadilla at low production costs. Aloe vera has therefore been used as a rooting hormone in crops like apples. Despite the widespread use of aloe vera as a rooting hormone in horticulture, the effects of aloe vera on root growth and development of granadilla plants are poorly understood. Studies have mainly focused on effects on other plant species, and effects on granadilla production have been poorly studied (Kasolo et al., 2015). Since granadilla is a high-value crop it is important to determine the potential benefits of using aloe vera as a rooting hormone for granadilla production.

1.3 Justification

The results of this study have important implications for the horticultural industry, especially for the production of granadilla plants. This information could have important implications for the horticultural industry, as the results of this project could lead to the development of more efficient and effective production methods for granadilla and other plant species. The use of Aloe vera as a rooting hormone has been shown to improve growth and productivity in various plant species (Kasolo et al., 2015), but its effects on granadilla production are poorly understood. By determining the effect of aloe vera on granadilla production, this study provides valuable information regarding the potential benefits of adopting the use aloe vera as a rooting hormone in granadilla production. This could lead to the development of more efficient and effective granadilla production methods that will benefit the entire horticultural industry.

In addition to its practical application, this study also contributes to the existing literature on the use of aloe vera as a rooting hormone in horticulture. By adding to the body of knowledge on this subject, this study helps advance our understanding of the potential benefits and limitations of making use of aloe vera as a root hormone in plant production.

1.4.1 Main objective

To determine the effects of using aloe vera as a root hormone in Granadilla propagation under hydroponics and in a soil based system.

1.4.2 Specific objectives

- To determine the effect of aloe vera on root number in granadilla plants grown in hydroponics and soil-based systems.
- To compare the shoot development rate of granadilla plants grown in hydroponic and soil-based systems treated with aloe vera.

1.5 Hypothesis

1.5.1 H0: Aloe vera has no effect on root number in granadilla plants grown in hydroponics and soil-based systems.

1.5.2 H0: Aloe vera has no effect on shoot development rate of granadilla plants grown in hydroponic and soil-based systems treated with aloe vera.

1.5.3 H1: Aloe vera has an effect on root number in granadilla plants grown in hydroponics and soil-based systems.

1.5.4 H1: Aloe vera has an effect on shoot development rate of granadilla plants grown in hydroponic and soil-based systems treated with aloe vera.

CHAPTER TWO

2.0 Literature Review

2.1 Granadilla and its benefits

Granadilla is a very popular alternative nutritious fruit plant for both fresh consumption and industrial use, as it is widely used in juices, jellies and ice creams. Zas, P and John, S (2016) reported that the granadilla plant has anti-inflammatory, antispasmodic, antibacterial, anticancer, antidiuretic, antihypertensive, seductive, antioxidant, and various therapeutic effects. Granadilla can be used to treat conditions such as osteoarthritis and asthma, and acts as a colon cleanser (Rocky Thokchom and Goutam Mandal, 2020).

The picture underneath shows the wholesome esteem of Granadillas

Nutrients	Nutritional value per 100g	Nutrients	Nutritional value per 100g
Energy	97 kcal	**Thiamine**	0.0 mg
Carbohydrate	23.38 g	**Vitamin A**	1274 IU
Protein	2.20 g	**Vitamin C**	30 mg
Total fat	0.7 g	**Potassium**	348 mg
Cholesterol	0.0 g	**Calcium**	12 mg
Dietary fibre	10.4 g	**Iron**	1.60 mg
Folates	14 µg	**Magnesium**	29 mg
Niacin	1.5 mg	**Phosphorus**	68 mg
Pyridoxine	0.1 mg	**Carotene**	743 µg
Riboflavin g	0.130 mg	**Crypto-xanthene**	41 µ

Figure 1 Granadilla nutritional value

2.1.2 Granadilla production

Granadilla (Passiflora edulis) is a perennial woody fruit tree belonging to the Passifloraceae family. It is a vigorous perennial vine with shallow roots that ascend using vines (Rocky Thokchom and Goutam Mandal, 2020). Granadilla is cultivated throughout the majority of the world's tropical and subtropical climates, with particular economic importance in Australia, Hawaii, South Africa, and Brazil. Brazil is the world's biggest producer of passion fruit, accounting for around 90% of total output, followed by Peru, Venezuela, South Africa, Sri Lanka, and Australia. Brazil's output is around 478,000 tons, with a yield of approximately 13.8 tons/ha. The northern and north-eastern parts of the country account for more than 80% of total national output (Joy PP, 2015).

In Zimbabwe granadillas are rarely grown and are very unique even though the local Zimbabwean climate is suitable for them. It is even common to see them naturally occurring. At optimum production, granadilla plants can realize as many as 20 tones per hector. Few farmers produce granadillas because many farmers do not have more knowledge of raising granadilla seedlings from seed or cuttings thus leading to scarcity of planting methods. Farmers are facing challenges with poor seed germination. Since granadillas have high yield if properly grown, the researcher will explore a method of propagating it using cuttings since granadilla seeds take time to germinate as stated by (Santos et al., 2012a; Gurung et al., 2014).

The worldwide passion fruit concentrate market was valued at roughly USD 465 million in 2019 and is expected to reach approximately USD 669 million by 2027 due to the usage of granadilla and nutritional composition, according to ReportLinker's Passion Fruit Market Forecast Report (2021). There are currently three Best Model Farmers in operation in Midlands, Mashonaland West, and Mashonaland. Green Afrique Technology will give assistance to growers that wish to export passion fruit.

2.1.3 Granadilla propagation

Studies on seeds of various granadilla species have shown challenges such as low and irregular germination rates. Seeds take a long time to germinate, resulting in uneven seedlings, which is a problem for seed cultivation (Souza Meletti, 1997). Another common challenge is that many granadilla fruit seeds are stubborn and lose viability quickly at room temperature. Decreased germination rate is common under various storage conditions, along with reduced germination rate and vigor (Santos et a l., 2012a; Gurung et al., 2014). Some granadilla species have problems with seed germination during sexual reproduction. Aspects related to seed dormancy, resilience, genetic and physiological quality directly influence the cuttings used in production system (Alexandre et al., 2004; Passos et al., 2004; Delanoy et al., 2006; Padua et al., 2011).

There are now procedures for producing passion fruit seedlings by asexual propagation via cutting, grafting, and micropropagation via tissue culture (Alexandare et al., 2009). The cultivation of attractive granadilla plants by rooting herbaceous cuttings has proven successful, with excellent rearing rates and sustainable plant production (Viana, 2016). The genetic and physiological features of the parental plants, varied reproductive strategies, substrate type, and treatment with regulators to increase rooting and graft production success are all important variables influencing asexual reproduction. The capacity to clone mother plants with appropriate agronomic features is the key advantage of this technology. When it comes to wild granadilla fruits like sour granadilla berries and sweet granadilla berries, it is critical to clonally choose plants with high productivity, huge fruit size, and high disease resistance and increase seedlings by asexual reproduction. When selected, it significantly increases productivity and improves orchard uniformity (Junqueira et al., 2006)

The proportion of beautiful passion fruit is similarly high (Viana, 2016), showing that the plant was successfully propagated via cuttings. Several articles on different granadilla cuttings (Paula et al., 2005; Braga et al., 2006; Roncatto et al., 2008a; Vaz et al., 2009) demonstrate that cuttings can grow new plants. It demonstrates that it is feasible. Responses differ by species, and in certain cases, the application of growth regulators such as dolebutyric acid and adjusting dosage may improve seedling production success (Vaz et al., 2009; Viana, 2016). There is still a need to investigate the effects of employing aloe vera as a root hormone in propagating granadilla cuttings and to investigate its impacts in cutting rooting, thus this study will concentrate on that.

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2.1.4 Rooting hormones

Numerous organic rooting agents have been reported for horticultural crop propagation. Cuttings of conifers and deciduous horticultural crops can both be propagated using natural rooting agents. In this regard, the use of natural root hormones in the propagation of horticultural crops is crucial (Pacholczak et al., 2016). Natural rooting agents are a low-cost and secure substitute for rooting garden crops. They are safe for the environment and can be used in place of artificial plant growth hormones like IBA (El-Sherif et al. 2017).

Salicylic acid, which is present in aloe vera, aids in the germination of cuttings. Salicylic acid encourages the growth of axillary and basal stem node-derived adventitious roots, but it prevents their elongation, leading to the development of a shallow root system. Salicylic acid encourages the development of root aerenchyma, a crucial anatomical adaptation that plants make in response to waterlogging (Murali Krishna et al., 20220). According to research by Shidiki et al. (2019), aloe vera performs better than IBA at rooting Vitex diversifolia semi-broadleaf cuttings. Phytohormones and nutrients found in aloe vera leaf extract include GA3 (16 mg/100 g wet weight), IAA (0.6 mg/100 g wet weight), ABA (3.1 mg/100 g wet weight), glucose (3 g/100 g), and protein (1 mg/g). There is report that aloe vera gel has IAA and it could be used as an alternative hormone (El-Sherif, 2017).

Salicylic acid and gibberellin, two growth hormones found in aloe vera gel, help plant shoots grow (Sahu et al., 2013). Gibberellins' effects on shoot growth are most notable for their increased internode, lengthened leaves, and increased apical dominance. Under certain circumstances, some plant species treated with aloe vera do not stimulate intact root growth, whereas some root segments respond to increased growth. Many forms of dormancy are disrupted by the gibberellins found in aloe vera. These include seed dormancy, potato tuber dormancy, shoot internodes and shoot (P. W.A.Brain, 2008).

Many people have shown similar results, indicating that applying aloe vera gel helps extend the root length of cuttings. Gibberellin, a tetracyclic diterpenoid phytohormone found in aleo vera, affects a variety of aspects of plant growth and development, such as increased internode length, increased leaf size and apical dominance in shoot growth, increased dry weight, disruption of seed dormancy, stem elongation, and flowering regulation (Gray, 2004; Brian, 2010). Gibberellins are known to have an impact on shoot length and growth, particularly by lengthening internodes (Brian 1959; Ram and Mehta 1978; Gupta and Chakrabarty 2013).

2.1.5 Hydroponics

Hydroponics is a method of growing plants in nutrient solutions with or without inert support materials like sawdust, gravel, vermiculite, rockwool, peat moss, or coco coir. The majority of hydroponic systems automatically adjust the amount of water, nutrients, and photoperiod based on the needs of the various plants (Resh, 2013).

Since plants in hydroponic systems can be grown all year round and are not impacted by seasonal changes, they are not considered out of season (Manzocco et al., 2011). Commercial hydroponics systems are labor-saving and automated. Additionally, it can help preserve some conventional farming techniques like tillage, spraying, watering, and weeding (Jovicich et al., 2003). Hydroponics saves a lot of water because there is no need for irrigation or other spraying and no flooding. Pest and disease problems are easy to overcome and weeds are rare. Compared to conventional cultivation, the number of plants per unit is larger, so thus leading to higher yield.

According to Sardare, crops grown in soil-less culture are healthier and consistently reliable than crops grown in soil (M .Samangooei, P.S SaSSi and A Lack, 2016). Maeva Makendi's experimental research revealed a competitive analysis between hydroponic and soil-based plant growth. According to the premise, "If soil-grown plants and hydroponic plants are given the same germination and growth conditions, the hydroponic plants will do as well as the soil-grown plants, if not better." For one month, various kinds of plants were used in the experiment. According to Catherine E. Snow and Kenne A. Dibner (2016), hydroponic plants did germinate and grow more quickly than soil plants. A study by Samangooei and colleagues compared two of the primary methods for producing food, soil-based and soil-less systems, and the productivity resulted in results that were similar to those of the Makendi study (Johy Wiley and Sons, 2013). Sardare contends that crops grown in soil-less culture are more wholesome and reliable over time than crops grown in soil (M. Samangooei, P.S. SaSSi, and A. Lack, 2016).

Although soilless cultivation is a useful technique, it has some serious limitations. Technical knowledge and high initial costs are prerequisites for commercial-scale cultivation (Resh, 2013). In a hydroponic system, plants all share the same nutrients, making it simple for water-borne diseases to spread from one plant to another (Ikeda et al., 2002).

CHAPTER THREE

3.0 Materials and methodology

3.1 Brief description of the study area

This study was carried out at Allenby farm in Kwekwe district in Midlands which is in agro-ecological zone three. The temperature normally fluctuates throughout the year, with an average annual high temperature of 29.72 degrees celsius and annual low temperature of 15.58 degrees celsius. The rainy season is typically overcast, the dry season is clear, and the weather is warm all year. Allenby receives about 86.06mm of precipitation and has 95.53rain days annually.

3.2 Experimental design

The design of this experiment was a 2*2 factorial experiment in a randomized complete block design (RCBD), where sixty cuttings of granadilla were treated with four treatments and replicated three times. The cuttings were assessed for root and shoot parameters starting at 3 weeks after planting upto week 6. Data collected were of the number of roots and shoots per cutting (by counting). Plants taken for recording data were taken at random. The recorded data were analyzed using the variance analysis method (ANOVA). Moreover, data obtained were analyzed using GENSTAT software and the level of significance of the treatments on cuttings of granadilla was determined.

Symbols	Description
SB	Soil Based
H	Hydroponics
TA	Treated with Aloe vera
TNA	No Aloe vera

3.3 Experimental procedure

The researcher started by collecting sand soil and washed it so as to flash the salts in soil then sterilized the sand with hot water and made sure that the soil was dry. Soil was mixed with compost in a proportion of 1 as to 1 so as to improve its nutrient status. Planting the cuttings in drained soil was done, this determines how fast the plants will develop roots.

To grow granadillas from cuttings, a clean sharp knife was used to cut the softwood granadilla stem just below their nodes. Three most bottom leaves and tendrils were removed after cutting to reduce transpiration and to prevent the plant from contracting fungal disease. Granadilla stems are softwood, which does not mean you cut them by hands without a pruner or knife. Plucking granadilla stems out from the vine with hands affect their germination. It damages the cell which affects the rooting system thus delaying germination process.

When using a knife to cut granadilla stems a slant cut was done thus making the stem to grow faster. Four to six inches granadilla cuttings were cut from healthy vines. If the length is below 4 inch the germination will be affected and such length will prevent the bottom leaves from coming in contact with soil to prevent fungal diseases.

Harvesting aloe vera leaf more than 2kg after selecting healthy plants and kept until brown color developed at the base point (harvested point). Aloe vera gel was then extracted along with brown color formed at harvest point. After development of a brown color, aloe vera leaf was cut at harvest point using a sharp knife this part was kept in a container. By using a knife to cut the cuticle, brown colored gel may be retrieved. After that, cuticle was ground and put to the container. With a knife, the latex-containing green cuticle of the aloe vera plant and the outer leaf pulp were scraped, mashed, and placed in the container. The gel from aloe vera was gathered and placed in a jar. According to a research by Gurpreet Signh, (2023), 100 ml of aloe vera gel in a container was combined with 1 liter of water at the time of therapy.

Half an inch hole was created to plant granadilla. Before planting granadillas were coated with aloevera then put half inch of granadilla stem inside the soil. Half inch is enough for nutrients to move up into all parts of the plants. After planting soil drainage was checked so as to avoid water logging because it rot the stem before germination. Before planting granadillas were coated with aloe vera Granadillas were then exposed under partial shade thus aiding to absorbance of more nutrients than full light that will dry up the water from soil.

For those in hydroponics 2liters of water and 200ml of aloe vera gel was mixed then granadilla 15 cuttings were put in each water trough. Four liters of water was mixed with 400 ml of aloe vera and was used to water each tyer. The set experiments were put under the shade so as to reduce transpiration. Water in hydroponics was changed after every 5 days so as to put fresh aloe vera and water thus preventing algae and fungal diseases. Watering was done in soil based system after every 5 days. These plants were exposed into partial sunlight for it aids to absorbance of more nutrients than full sunlight that will dry up the water from soil.

3.4 Data collection

Data was collected starting from 3 weeks after planting because thus when rooting was anticipated to start. Three plants were selected at random from each treatment and data was recorded .The data about number of roots on each cutting was recorded and the number of new shoots on each cutting was were recorded .Recordings of number of roots and shoots on randomly selected cuttings were taken by counting the number of shoots and roots after every week starting at 3 weeks after planting until records were taken 4 times. The granadillas cuttings were uprooted to collect data in soil based system. Care during uprooting was done. The selected uprooted plants were thrown away after recording.

3.5 Data analysis

Using Genstat Version 18, the data was examined using the ANOVA method. The least significant difference (LSD) was used to separate means where there were significant differences.

CHAPTER FOUR

4.0 Data Presentation

This chapter shows data presentation on root number and shoot number of the granadillas in hydroponics and in soil based system treated with the aloe vera and without aloe vera as a root hormone.

Fig 4:1 Number of roots developed at different weeks in hydroponics and soil based system with aloe vera and without aloe vera.

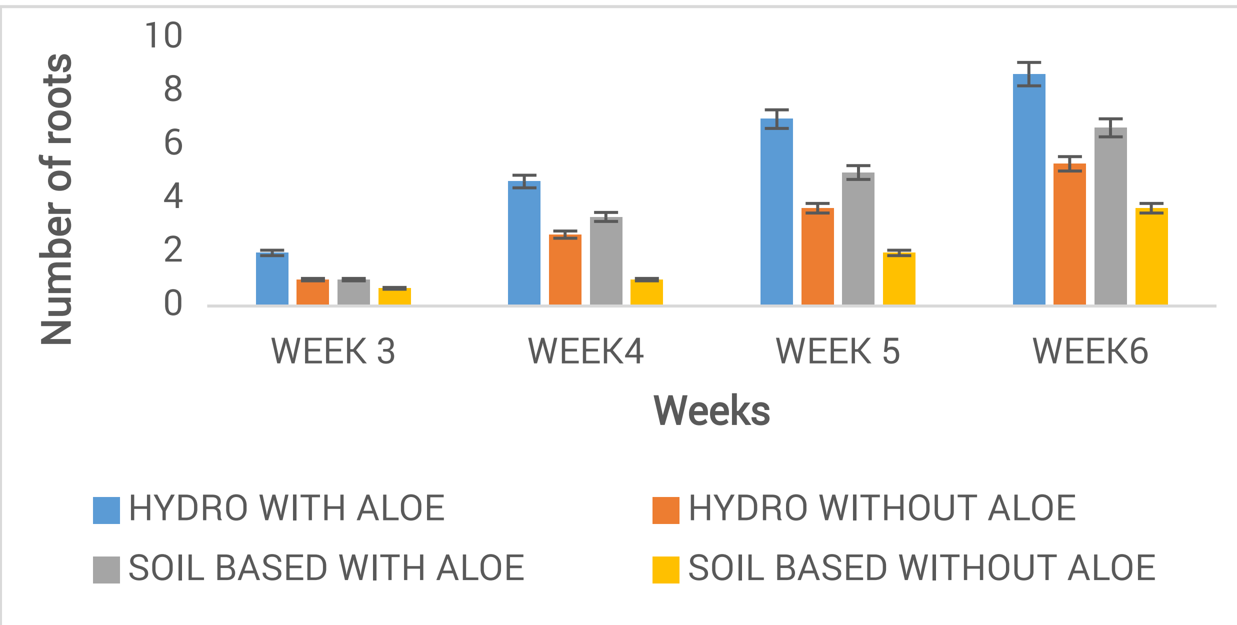

Figure 2 Root development

Fig 4.1 shows the root number developed at different weeks in hydroponics and soil based system with aloe vera and without aloe vera .The effect of aloe vera at week 6 showed a significant difference (p <.001) on media where as their interactions also showed significant difference where P< 0.635 . Hydroponics with aloe vera showed high rate of root development of 8.67 compared to hydroponics without aloe vera or even compared to soil based with aloe vera or without. Soil based without aloe vera showed the least number of roots of 3.67 that have developed.

Fig 4:2 Number of shoots developed at different weeks in hydroponics and soil based system with aloe vera and without aloevera.

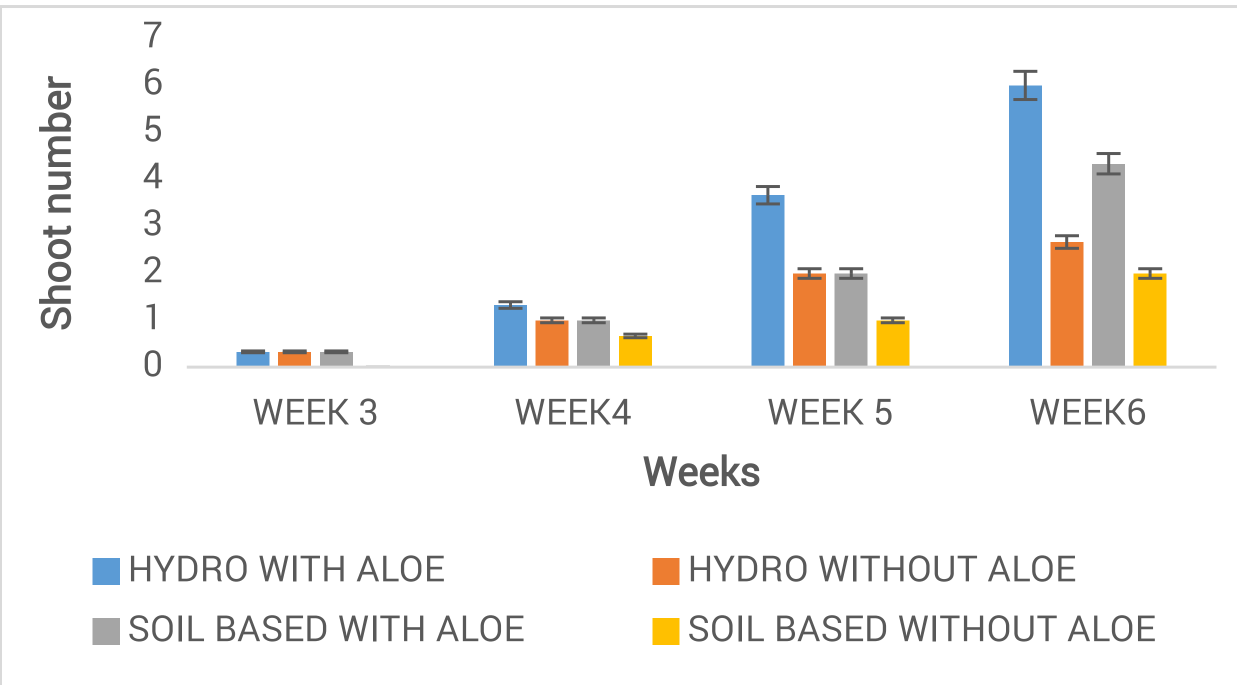

Figure 3 Shoot development

Fig 4:2 shows number of shoots developed at different weeks in hydroponics and soil based system with aloe vera and without aloe vera .The effect of aloe vera at week 6 showed a significant difference at $p<.001$ on shoot development at $p<0.002$ on media where as their interactions showed $p< 0.059$ significant difference. Hydroponics with aloe vera showed high rate of shoot development of 6 compared to hydroponics without aloe vera or even compared to soil based with aloe vera or without. Soil based without aloe vera showed the least number of shoots of 2 that have developed.

CHAPTER 5

5.0 Discussion

Hydroponics with aloe vera showed highest rate of root and shoot development compared to hydroponics without aloe vera or even compared to soil based with aloe vera or without. Soil based without aloe vera showed the least number of shoots and roots.

Aloe vera proved to have an effect in rooting of granadilla cuttings in both medium. This may be due to the fact that Aloe vera contains salicylic acid, which aids in rooting of cuttings. It is supported by (Sahu 2013) who stated that it contains growth hormones such as gibberellin and salicylic acid that aids growth of the plant. The presence of hormones such as auxin, IAA and gibberellin in aloe which promote plant root growth has also been documented (Dagne et al., 2000).

IAA hormones aid cell division and cause the formation of adventitious and lateral roots. Natural auxin stimulates callus formation and root development. Auxin treatment in cuttings promotes cytokinin activation, allowing for the uptake of reserve food material. Cytokinins ensure rapid formation of food material in cuttings (Hasan et al., 2020). Salicylic acid encourages the growth of axillary and basal stem node-derived adventitious roots, but it prevents their extension, leading to the development of a shallow root system. According to Murali Krishna et al. (2020), salicylic acid encourages the growth of perseveration tissue, a crucial anatomical adaptive response of plants to waterlogging.

Comparing results from the two media, cuttings in hydroponics had high root number to those in soil based system .This may be due to the fact that aloe vera in hydroponics was directly delivered to the rooting zone of the cutting however in a soil based system some aloe vera was held by the soil particles before being delivered to the rooting zone of cuttings so the cuttings received less aloe vera amount thus resulting in less root developmet in a soil based system.

The number of shoots that have developed was high in both media with aloe vera compared to that without aloe vera. Aloe vera gel is a great source of plant nutrients like calcium, iron, magnesium, potassium, phosphorous, and zinc (Dagne et al., 2000); amino acids like alanine, glycine, and leucine; vitamins B complex and C,B-carotene; and some other organic compounds like gibberellin and salicylic acid; Reynolds and Dweck, 1999).

As Brain (1959) points out, the high shoot development may be due to gibberellin, which affects shoot elongation. Gibberellins in aloe vera promote leaf growth. Aloe vera contains glycine, which stimulates root and shoot growth. Amino acids are excellent sources of nitrogen for plant uptake and utilization, stimulating shoot growth. The tetracyclic diterpenoid plant hormones known as aloe vera gibberellins control important aspects of plant growth and development, including increased internode expansion, increased leaf growth, increased apical dominance in shoot growth, increased dry weight, disruption of seed dormancy, stem elongation, and controlled flowering (Gray, 2004; Brian, 2010). Additionally, amino acids help in shoot regeneration. Aloe vera's magnesium concentration promotes the generation, transport, synthesis, and usage of chlorophyll, which results in the growth of shoots (Shekh Rahman et al., 2017).

CHAPTER 6

6.0 Conclusion

The study showed that there was a significant difference between granadilla cuttings in media with aloe vera and those in media without aloe vera. In media with aloe vera there was high root and shoot number development so this indicate that aloe vera have an effect of increasing root and shoot number in granadilla cuttings. This study showed that media have an effect on root number and shooting in granadilla cuttings. Hydroponics proved to be a better media compared to soil based system since it recorded high root number and high shooting despite the presence of aloe vera

6.1 Recommendations

1. Farmers are recommended to adopt the use of aloe vera as a root hormone in propagating granadilla cuttings since aleo vera have a positive effect in root biomass and shooting like commercial rooting hormones which are costly.

2. When propagating granadilla cuttings the farmers are recommended to adopt the use hydroponics since it encourages more shoot and root formation.

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APPENDIX

Analysis of variance

Variate: root_nu_w3

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	0.16667	0.08333	1.00	
Block.*Units* stratum					
Media	1	1.33333	1.33333	16.00	0.007
Root_Hormone	1	1.33333	1.33333	16.00	0.007
Media.Root_Hormone	1	0.33333	0.33333	4.00	0.092
Residual	6	0.50000	0.08333		
Total	11	3.66667			

Analysis of variance

Variate: root_nu_w4

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	0.1667	0.0833	0.27	
Block.*Units* stratum					
Media	1	6.7500	6.7500	22.09	0.003

Root_Hormone	1	14.0833	14.0833	46.09	<.001
Media.Root_Hormone	1	0.0833	0.0833	0.27	0.620
Residual	6	1.8333	0.3056		
Total	11	22.9167			

Analysis of variance

Variate: root_nu_w5

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	0.6667	0.3333	1.00	
Block.*Units* stratum					
Media	1	10.0833	10.0833	30.25	0.002
Root_Hormone	1	30.0833	30.0833	90.25	<.001
Media.Root_Hormone	1	0.0833	0.0833	0.25	0.635
Residual	6	2.0000	0.3333		
Total	11	42.9167			

Analysis of variance

Variate: root_nu_w6

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	0.6667	0.3333	1.00	
Block.*Units* stratum					
Media	1	10.0833	10.0833	30.25	0.002
Root_Hormone	1	30.0833	30.0833	90.25	<.001
Media.Root_Hormone	1	0.0833	0.0833	0.25	0.635
Residual	6	2.0000	0.3333		
Total	11	42.9167			

Analysis of variance

Variate: shoot_nu_w3

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	0.5000	0.2500	1.00	
Block.*Units* stratum					

Media	1	0.0833	0.0833	0.33	0.585
Root_Hormone	1	0.0833	0.0833	0.33	0.585
Media.Root_Hormone	1	0.0833	0.0833	0.33	0.585
Residual	6	1.5000	0.2500		
Total	11	2.2500			

Analysis of variance

Variate: shoot_nu_w4

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	0.0000	0.0000	0.00	
Block.*Units* stratum					
Media	1	0.3333	0.3333	1.50	0.267
Root_Hormone	1	0.3333	0.3333	1.50	0.267
Media.Root_Hormone	1	0.0000	0.0000	0.00	1.000
Residual	6	1.3333	0.2222		
Total	11	2.0000			

Analysis of variance

Variate: shoot_nu_w5

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	0.16667	0.08333	1.00	
Block.*Units* stratum					
Media	1	5.33333	5.33333	64.00	<.001
Root_Hormone	1	5.33333	5.33333	64.00	<.001
Media.Root_Hormone	1	0.33333	0.33333	4.00	0.092
Residual	6	0.50000	0.08333		

Total 11 11.66667

Analysis of variance

Variate: shoot_nu_w6

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.

Block stratum	2	0.5000	0.2500	1.80	
Block.*Units* stratum					
Media	1	4.0833	4.0833	29.40	0.002
Root_Hormone	1	24.0833	24.0833	173.40	<.001
Media.Root_Hormone	1	0.7500	0.7500	5.40	0.059
Residual	6	0.8333	0.1389		
Total	11	30.2500			