STUDIES OF ROOTING MEDIA AND THEIR pH ON THE ROOTING BEHAVIOUR OF STEM CUTTINGS OF GUAVA (*Psidium guajava* L.) UNDER HIMALAYAN FOOT HILLS CONDITIONS

Thesis Submitted for the Award of the Degree of

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Horticulture - Fruit Science

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DECLARATION

I, hereby declared that the presented work in the thesis entitled "Studies of rooting media and their pH on the rooting behaviour of stem cutting of Guava (*Psidium guajava* L*)* under Himalayan foot hill conditions" in fulfilment of degree of **Doctor of Philosophy (Ph. D.)** is outcome of research work carried out by me under the supervision Dr. Gurpreet Singh, working as Associate Professor, in the Department of Horticulture, School of Agriculture, Lovely Professional University, Punjab, India. In keeping with general practice of reporting scientific observations, due acknowledgements have been made whenever work described here has been based on findings of other investigator. This work has not been submitted in part or full to any other University or Institute for the award of any degree.

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CERTIFICATE

This is to certify that the work reported in the Ph.D. thesis entitled "Studies of rooting media and their pH on the rooting behaviour of stem cutting of Guava (*Psidium guajava* L*)* under Himalayan foot hill conditions" submitted in fulfillment of the requirement for the reward of degree of **Doctor of Philosophy (Ph.D.)** in the Department of Horticulture, School of Agriculture, a research work carried out by Prabhat Kumar, Registration No.11919659, is bonafide record of his original work carried out under my supervision and that no part of thesis has been submitted for any other degree, diploma or equivalent course.

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Table of Contents

List of Tables:

List of Figures:

List of Abbreviations:

RH	Relative Humidity
EC	Electrical Conductivity
pH	Potential of Hydrogen
SWC	Soil Water Content
STC	Soil Temperature Content
RD	Rooting Depth
RT	Rooting Time
PI	Rooting Performance Index
G1	Open Conditions 2021
G2	Protected Conditions 2021
G3	Open Conditions 2022
G4	Protected Conditions 2022
Mg	Milligram
PPM	Parts per Million
CD	Critical Difference
SE(m)	Standard Error of Mean
IBA	Indole 3-butyric acid

Abstract:

Guava *(Psidium guajava* L.*)* plants, a member of the family Myrtaceae, bear climacteric fruits and are usually known as the apple of the tropics. Its origin is in tropical America, and it adopted well for commercial cultivation throughout the tropics due to its hardy nature. Under the Himalayan foothills, an investigation was carried out to determine how the semi-hardwood stem cuttings of guava *(Psidium guajava* L.*)* responded to different rooting mediums and how their pH affected the rooting process. Sand (S), sawdust (SD), and a mixture of the two, sand and sawdust (SSD), were all used as rooting mediums over the course of the study, which resulted in the creation of three unique media treatments. At the beginning of the experiment and again after 30 days of observation, phenol red was used to determine the pH levels of the three different medium treatments. Cuttings of semi-hardwood stems were taken from the guava tree and then planted in each of the three experimental medium treatments. For a period of one month, observations were made about how the cuttings fared in terms of taking root. The findings of the experiment revealed that the combination of sand and sawdust (SSD) had the highest rooting success rate (94.5%), followed by sand (S) with a rooting success rate of 87.5% and sawdust (SD) with a rooting success rate of 70%. The experiment was conducted to determine whether or not sand, sawdust, or a combination of the two would result in the best rooting success rate. In addition, the experiment demonstrated that after a period of 30 days, the pH of each of the various medium treatments had reduced. Based on the findings of this experiment, a mixture of sawdust and sand may function as the most effective rooting medium for semi-hardwood stem cuttings.

Keywords: Cutting, Propagation, pH and rooting media

Introduction

1. Introduction:

The Himalayan foothill region is characterized by its diverse range of soils and climatic conditions. The soil types in this region vary from sandy loams to clay loams, and the climate ranges from subtropical to temperate. Guava *(Psidium guajava* L.*)* is a tropical fruit tree that is native to the Himalayan foothill region. Guava trees are relatively tolerant to a wide range of soil and climatic conditions. However, the rooting behaviour of guava stem cuttings can be affected by the type of rooting medium and the pH of the rooting medium. *(Yahia, 2019).*

1.1 History of Guava:

It is believed that the guava fruit came from somewhere in South or Central America. Although humans have played a significant part in dispersing guava seeds, other animals and birds have also been responsible for this. Guavas are now cultivated in the states of Florida, Hawaii, and southern California. The guava tree is very resilient, and it may bounce back from potentially fatal conditions such as extreme cold, high temperatures, lack of care, and water logging. *(Awasthi et al.,2021).*

In the 17th century, the guava was introduced to India and Asia, where it quickly became a popular fruit. This popularity was due to its high nutritional value, which included vitamins A, B, C, and E. It was also noted for its high fibre content, which made it a favourite among those looking to maintain a healthy diet. In the United States, guavas were first introduced in the late 1800s, and quickly became popular in many parts of the country.*(Hossen et al., 2011)* Florida, guavas were cultivated for their fruit, as well as for their leaves, which were used for medicinal purposes. Guavas were also popular in Hawaii, where they were used to make a sweet, sour-tasting syrup called guava nectar.

In the 19th century, guavas were especially popular in the Caribbean and Latin America. In Cuba, guavas were used to make a sweet, creamy beverage called guava ice cream, which was made with a combination of guavas and cream. In Mexico, guavas were used to make jellies, jams, and marmalades. In the late 19th century, the guava began to be cultivated throughout the Caribbean. In 1881, the first commercial guava plantation was established in Jamaica, and within the next decade the fruit had become a major cash crop in much of the Caribbean *(Ismail et al., 2010)*. Guava cultivation spread rapidly throughout the region and a substantial export market was developed, with much of the fruit being sent to the United

States and Europe. In the 1880s, the guava was introduced to Florida and within a few years had become an important cash crop in the state.

The introduction of guava to Florida had a major impact on the global consumption of the fruit. The mild climate of the state allowed for the cultivation of guava throughout the year, and the export market for the fruit expanded substantially. By the early 20th century, the guava had become a popular fruit throughout the United States and Europe *(Rajamanickam et al., 2021).*

1.2. Guava Cultivation in India:

The cultivation of guavas in India currently has a generally favourable reputation. The sweetness, flavour, and fragrance of Indian guavas have contributed to the fruit's rise to prominence as a consumer favourite in India. The nation is the most important producer of guavas in the world, responsible for around 70 per cent (%) of total output. Guava farming is a significant part of India's agricultural industry, and the country's practically completely covered with guava plantations. India is a fantastic location for the development of guavas due to its great temperature and soil characteristics *(Lal et al., 2007)*. The production of guava has also shown to be incredibly beneficial for farmers due to the high prices that guavas garner on the market. In addition, the cultivation of guava is extremely simple, needing just a little amount of care and attention. In addition, the government is supporting the production of guavas via a variety of initiatives, including the distribution of subsidies, the promotion of the use of organic fertilizers, and the implementation of strategies for the control of pests. *(Sardoei, 2015).*

1.3. Commercial Propagation:

Cuttings, air layering, and grafting are only some of the artificial procedures that are used in the commercial propagation of guava. The most typical technique is called cutting, and it involves cutting off a branch of the guava tree and then applying a rooting hormone to the cut end of the branch before planting it in a container of soil. During the air layering process, a guava tree limb is kept in touch with the ground for a period of a few weeks in order to encourage the development of adventitious roots. Grafting is the most labour-intensive and costly way of propagation since it requires chopping off a branch of one guava tree and then connecting it to the rootstock of another guava tree.*(Ahmad et al., 2016).*

Both seeds and stem cuttings may be used to grow new guava plants. Because it is simpler and more expedient than growing from seed, stem cuttings are the form of propagation that is most often used. When using stem cuttings as a method of plant propagation, it is critical to choose the appropriate Rooting media and to maintain the appropriate pH level. Guava *(Psidium guajava L.)* exports are fairly restricted. In spite of this, the company's juice and canned goods are becoming more well-known, which may pave the way for the establishment of a cottage industry.*(Singh & Sahare, 2019)*. The steady rise in consumer demand for fresh guava has been met by steady increases in production of fresh guava, which have been adequate to meet that need. The plant is able to produce two harvests each year, one during the dry season and another during the rainy monsoon season. Both harvests are capable of occurring in alternating years. It is possible that the high value of the fruit may be related to the significant demand that it gets both as a delectable dessert and as a raw material for the production industry. It is possible that the many ways in which the guava fruit may be prepared and consumed would be beneficial to both rural economics and nutritional standards, which in turn serves to strengthen rural economies. In addition to this, the guava tree is able to survive extended periods of drought. In addition to having a high nutritive value, it also has a big impact on the economy as a consequence of the large yearly yields that it generates. This is because of the fact that it can be grown in a variety of environments. This has led to a direct consequence in the form of a number of farmers beginning production of guavas on a huge scale. It wasn't until the 17th century that it first started being grown as a crop for economic reasons on farms. *(Nucleus et al., 2017).*

In horticulture, one of the most essential variables that contributes to the fruitful multiplication of plants is the medium used for rooted cuttings. When it comes to taking root, many plant species have varying needs, and the kind of Rooting medium that is used may have a considerable influence on how successful the propagation process is. Rooting medium is one of the most critical components in the effective multiplication of plants and is considered one of the most important factors overall. The medium in which the plant is grown is referred to as the Rooting media, and the quality of this medium may have a considerable bearing on how successful the propagation process is. It is essential to choose the Rooting medium that is most appropriate for the specific plant species you are working with since the Rooting needs of various plant species are distinct from one another. *(Shahzad et al., 2019).*

There are a number of factors that need to be considered when selecting the Rooting media, including the type of plant, the climate, the soil type, and the availability of water. The type of plant is one of the most important factors to consider when selecting the Rooting media. Different plant species have different Rooting requirements, and it is important to select the Rooting media that is best suited for the particular plant species. The climate is another important factor to consider when selecting the rooting media. The climate can have a significant impact on the success of the propagation, and it is important to select the Rooting media that is best suited for the particular climate. *(Kumar et al., 2022).*

Semi-hardwood stem cuttings of guava are sensitive to rooting medium and pH. The low temperatures and heavy humidity typical of the Himalayan foothillmight hinder the roots of guava semi-hardwood stem cuttings. In this article, we will examine the effects of rooting medium and pH on the resiliency of guava semi-hardwood stem cuttings in the humid environment of the Himalayan foothills. When analysing the effects of pH on rooting behaviour, it is essential to take into account the particular kind of soil. The process of roots may be affected in a variety of unique ways by various types of soil. For instance, soils that are rich in clay tend to have a lower pH, and as a result, they may be more challenging to deal with. Clay also tends to bind water, making it more difficult to drain. Sandier soils, on the other hand, tend to have a higher pH and are often less difficult to deal with. In general, the pH of the soil has the potential to have a considerable influence on the process of roots. When it comes to Rooting medium, the pH is another factor that must be taken into consideration. The process of Rooting may be affected in a variety of ways depending on the medium used. For instance, media that is heavy in clay content often has a pH that is lower than average and, as a result, might be more challenging to deal with. On the other hand, media that has a larger per cent (%)age of sand tends to have a higher pH and is often less difficult to manipulate. In most cases, the degree to which the pH of the Rooting medium affects the process of Rooting may be considered important. Semi-hardwood guava stem cuttings respond quite differently to Rooting environments with varying pH levels. Cuttings obtained from healthy, young plants usually root more successfully in medium with a pH of 5.5 to 6.5. Media with a pH between 6.5 and 7.5 is ideal for Rooting cuttings taken from older, less robust plants. (Sharma & Singh, 2021).

1.4. Cuttings:

Guava is difficult to root. It may be effectively propagated from misted cuttings. Auxins such as IBA, IAA, and NAA stimulated the Rooting of soft and semi-hard wood cuttings. Girdling 20 days before collecting cuttings, keeping it in etiolation for 10 days and sunshine for 10 days, and treating with IBA (3000 ppm) also produced the greatest results. Seasonal influences adventive root development as well. *(Qadri et al., 2018).*

1.5. Factors Influencing Rooting of Cutting:

The capability of various plant species to root varies considerably. The rooting of cuttings is affected by a number of internal and external variables, including:

1.6. The physiological position of the parent plant

The physiological position of the parent plant is a concept that involves a number of different factors that influence the development and growth of the plant. It is important to consider the various factors in order to ensure the optimal growth and health of the plant.

The first factor to consider is the soil. The soil is the primary source of nutrients for the parent plant, and thus, it is important to select a soil that is appropriate for the particular plant species. The soil should be well-drained, with an adequate supply of organic matter and a balanced pH level. Additionally, the soil should be tested for any potentially toxic substances, such as heavy metals and pesticides, that may be present. The second factor to consider when discussing the physiological position of the parent plant is the amount of light it receives. Different plants require different levels of light, and it is important to select the appropriate amount for the particular species. Ideally, the parent plant should receive direct sunlight for at least six hours per day. If this is not possible, then artificial lighting should be used to supplement the natural light. The third factor to consider is the amount of water the parent plant receives. In general, most plants require both regular watering and occasional fertilization in order to thrive. *(Nikumbhe, 2022)*

1.7. The physiological condition of the mother plant may have a substantial impact on the rooting of cuttings. For example, cuttings obtained from plants with little water often have inadequate roots.

- When gathered in the early morning, when plants are hydrated, cuttings root more effectively than those obtained from dried plants.
- Root development from cuttings is also significantly affected by the nutritional state of the parent plant. A parallel may be drawn to the prior argument. Evidence suggests that the highest carbohydrate content of the year occurs in the fall, making it the ideal time to take cuttings of fruit trees like apples and raspberries and force them to root and sprout. The survival per cent (%)age of summer cuts is much lower. *(Suraj et al., 2019).*
- Over-fertilized plants flourish, yet their cuttings fail to establish deep enough roots when transplanted elsewhere. Therefore, low nitrogen levels and high carbohydrate content in the stock plant are necessary for enhanced root development. Preventing the downward transport of CHO, hormones, and other root-promoting chemicals has been demonstrated to have promising results in the quest for better Rooting. To do this, you may girdle the plant to reduce its CHO stores.
- The production of roots from cuttings is also influenced by conditions inside the plant, such as auxin concentration, the presence of Rooting cofactors, and the availability of choline. Girdle branches before utilizing them as cuttings to enhance root growth. *(Khas et al., 2020).*

1.7.1. Juvenility factors

The Juvenility factor relates to the capacity of the plant to root from a cutting. The degree of success will be determined by a variety of variables, including the plant's species, the time of year, the age of the cutting, the state of the cutting, the environment, and the quality of care provided. This brief will examine the many Juvenility elements that impact cutting Rooting and give Rooting techniques.

The capacity of a plant to root from a cutting varies according to species. Some plants are more adaptable than others and will root better. Many succulents and cacti, for example, root readily, whilst others may be more difficult, if not impossible, to root. *(Multiplication, 2018)* Before trying to root a plant from a cutting, it is critical to study the species.

- By utilizing techniques like heading back, spraying GA3, inducing sphaero blasts, Rooting, grafting adult forms onto juvenile forms, and/or dis-budding, it is feasible to purposefully induce juvenility in mature plants. *(Multiplication, 2018).*

1.7.2. Type of the wood

Wood type is a major factor in determining the success of a cutting's Rooting. Different types of wood affect the Rooting of a cutting in different ways. One type of wood that affects the Rooting of a cutting is softwood. Softwood typically comes from coniferous trees like pine, spruce, and fir. It is generally light in colour, with a soft texture, and can be easily cut. Softwood cuttings are best taken from young, green shoots. These cuttings tend to root quickly and easily and are well-suited for vegetative propagation. *(Irshad et al., 2020).*

Hardwood, on the other hand, comes from deciduous trees like oak and maple. Hardwood is usually darker in colour and dense than softwood, and it can be a bit more difficult to cut. Hardwood cuttings tend to be slower to root than softwood cuttings, but they tend to have more stable root systems once they do take. Hardwood cuttings are best taken from semi-hardwood shoots, which are more mature than softwood cuttings but still young enough to have a good Rooting potential. *(Suman & Bhatnagar, 2019).*

1.7.3. Availability of leaves and buds

The Rooting of cuttings is a common technique used in horticulture and agriculture to propagate plants. The presence of leaves and buds on cuttings can influence the Rooting process, making it more successful and efficient. This paper provides a brief overview of the role of leaves and buds in the Rooting of cuttings.

It is well-established that leaves and buds play an important role in the Rooting of cuttings. The presence of leaves on the cutting improves the success rate of Rooting. This is because leaves provide the cutting with the necessary energy needed for root formation. In other words, leaves enable the cutting to access the carbohydrates and other nutrients needed for root development. Additionally, leaves allow for the absorption of light, which helps to stimulate the development of roots. *(Suman.M & Bhatnagar.P, 2019).*

- The stimulatory effect that buds have on roots during the inactive period may be due to the increased auxin supply and decreased inhibitor supply to the basal part of the cutting. Conversely, in certain species, removing the leaves may reduce water loss due to transpiration.

1.7.4. Position of the initial cut in the cutting

The basal cut process involves cutting off the lower branches and the main stem of the guava tree. This is done to reduce the number of leaves and shoots that are supported by the main stem of the tree. This will encourage the growth of new shoots and leaves from the base of the tree. It will also help to reduce the competition among the branches that are supported by the main stem.*(Sujin et al., 2020).*

The basal cut should be done in a precise manner. The cuts should be made at least 1 inch above the soil line. This will ensure that the cuts are made at the right level and will also help to reduce the risk of infection. The cuts should also be made at angles, and the branches should be cut close to the base of the tree.
The basal cut should be done in the early part of the season when the growth of the guava.

When cutting certain plants, make the cut slightly above or below the node; when cutting others, make the cut at the node; and when cutting yet others, the placement of the cut has no effect on the root initiation process. *(Swapnil et al., 2019).*

1.7.5. Season

The seasons have a major influence on the Rooting of cutting in guava trees. During the spring and summer months, guava trees tend to produce more vigorous and healthy root growth. This is because the warm temperatures and long days encourage the tree to produce more growth hormones, which can lead to better root development. In addition, the increased amount of sunlight helps to create a more humid environment, which is essential for promoting root growth.

During the fall and winter months, guava trees tend to produce less vigorous root growth. This is because the cooler temperatures and shorter days decrease the amount of growth hormones produced by the tree. In addition, the decreased sunlight and humidity make it difficult for the roots to develop properly. Therefore, it is important to take advantage of the spring and summer months to propagate guava cuttings, as this is when the roots are likely to develop more quickly and robustly. *(Singh et al., 2022).*

1. Cuttings treatment:

Guava cultivation often involves guava cutting to promote the establishment of healthy, high-yielding, and disease-resistant plants. Producers may regulate the growth and form of a guava tree, as well as limit its susceptibility to pests and diseases, by pruning the tree's branches and stems.

The method of cutting may significantly affect the growth and development of guava trees. The branches and stems are clipped to the proper size and form during the cutting process. This promotes robust and healthy development in addition to a consistent canopy structure. In addition to preventing the spread of disease, pruning increases the quantity of sunshine and airflow that reaches the tree's leaves and fruit.

In addition, pruning promotes the development of new branches, which increases the total quantity of fruits produced. This is significant for both commercial and amateur growers, since it boosts the guava tree's output. Pruning also improves the quality of the fruit by eliminating sick or damaged tree branches.

Finally, pruning may reduce the amount of time and resources required for guava tree maintenance. Producers may decrease by eliminating any overgrown or weak branches and stems. Numerous studies have shown that cuttings may be treated with a number of substances prior to planting in order to induce root development. Among the possible treatments are growth regulators, mineral fertilisers, fungicides, wounding, etiolation, and stem cuttings. *(Ahmad et al., 2016).*

- **Use of growth regulators:** It has been observed that, among growth regulators, IBA is the most effective component for encouraging root development in cuttings from the vast majority of plant species. This observation was made. The concentration varies from plant to plant and depends on the kind of cuttings utilised. NAA, 2, 4-D, and 2, 4, 5-T are further examples of auxins that stimulate root development. However, 2, 4-D and 2,4, 5-T are also strong herbicides that may inhibit the development of shoots in some plant species. In addition to the species and kind of cuttings used, their success and level of concentration are also reliant on these factors. While NAA and 2, 4-D are unaffected by light, IAA is very photosensitive and will decay when exposed to intense sunlight. *(El-zayat, 2010).*

- **Wounding:** Wounding may be helpful in cuts when old wood is used as a foundation. In a number of ways, wounding accelerates the Rooting of cuttings:
  - The sclerenchyma rings, which are made up of tough cells in the cortex and are positioned outside of the region of genesis, are separated upon wounding, allowing cuttings to root more rapidly.
  - It helps the Rooting medium's moisture and nutrient content be absorbed more effectively and Hormones are released more rapidly after an injury, leading to a faster breathing rate.
  - When cells are damaged, they and their neighbours divide more quickly.
  - Damaged cells release ethylene, a hormone that stimulates root development, when they die.

All of these conditions, brought on by the injury, help the beginning of the Rooting process get off to a good start.

Girdling: To girdle a shoot, a ring of bark is removed from its base, often ranging between 2.5 and 3.0 centimetres in diameter. This bark ring is then fabricated into blades. Other methods include notching the shot or encircling it with wire to accomplish the same result. This method aids the initiation of root development in some plant species much before it would have occurred naturally. Girdling impedes the downward flow of carbohydrates, hormones, and other chemicals that stimulate root development. Depending on the plant species, girdling at different times and from different locations may be necessary. However, around ten to fifteen days before preparing cuttings from these plants, the shoots should be girdled. This is also true for citrus roots.

- **Rooting medium:** A suitable medium should be permeable to water and air and have a large capacity for both. It has to drain well and be sterile. The media must provide three crucial functions.

(i) It ought to hold the cutting in the appropriate manner.

(ii) It need to provide the cuttings with a suitable amount of moisture.

(iii) It has to allow unobstructed air circulation all the way down to the base of the cuts. *(V.Lotfy et al., 2021).*

When certain cuttings are placed in sand, the resulting roots are long, unbranched, and brittle; yet, when other cuttings are planted in perlite or peat mixes, the resulting roots are well-branched, thin, and flexible. It is widely agreed upon that a pH in the neighbourhood of 7.0 is ideal for the process of rooted cuttings, and that this range should be maintained throughout. It is essential to make certain that the medium in which the roots are to be established does not include an excessive quantity of calcium that may be replaced, since this might have a detrimental effect on the Rooting process. especially It's possible that peat moss will affect the Rooting procedure. *(Awasthi et al., 2021b).*

4. Problem Background:

The successful propagation of guava (*Psidium guajava* L.) through stem cuttings is a critical aspect of horticultural production in the Himalayan foothills. However, the rooting behavior of semi-hardwood stem cuttings in this region presents a complex challenge due to the interplay of various factors. Research has shown that the choice of rooting media, the pH level of the media, and the unique environmental conditions of the Himalayan foothills all significantly influence the success of rooting.

Rooting Media: The composition of the rooting media plays a crucial role in providing the necessary physical and chemical environment for root initiation and development. Studies have demonstrated that different rooting media, such as sand, perlite, vermiculite, peat moss, and various combinations thereof, can exhibit varying degrees of success in promoting rooting in guava cuttings (Hartmann et al., 2018). The porosity, water holding capacity, and nutrient availability of the media are key considerations in determining its suitability for rooting.

pH: The pH level of the rooting media is another critical factor that affects the availability of essential nutrients and influences the activity of enzymes involved in root formation. Research suggests that guava cuttings prefer a slightly acidic to neutral pH range (5.5-7.0) for optimal rooting (Awasthi et al., 2014). Deviations from this range can hinder nutrient uptake and disrupt physiological processes, leading to poor rooting performance.

Himalayan Foothill Conditions: The Himalayan foothills present a unique set of environmental conditions characterized by varying temperatures, humidity levels, and rainfall patterns. These conditions can exert significant stress on plant cuttings and influence their rooting ability. Additionally, the soils in this region can vary in their physical and chemical properties, further adding to the complexity of the rooting process.

Previous Research: Padmapriya et al. (2019) conducted a study on optimizing rooting media for guava propagation, highlighting the importance of selecting appropriate media for successful rooting. However, their study did not specifically focus on the Himalayan foothill conditions. Awasthi et al. (2014) investigated the effects of different IBA concentrations, rooting media, and time on the rooting behavior of guava, emphasizing the importance of pH and media interactions. However, their research did not consider the specific environmental challenges of the Himalayan foothills.

This Research: Building upon previous research, this study aims to comprehensively investigate the effects of various rooting media and pH levels on the rooting behavior of semi-hardwood stem cuttings of guava under the specific environmental conditions of the Himalayan foothills. The findings of this research will provide valuable insights into the development of effective propagation protocols for guava in this challenging region, contributing to the advancement of horticultural practices and enhancing productivity.

Objectives:

- To standardize the suitable rooting media combination on root induction behavior of guava cuttings.
- To study the effect of different levels of pH of the rooting media on rooting behavior of guava cuttings.
- To find out the cost effective method in rooting of cuttings of guava.

Literature Review

2. Literature review

In this section, the reviews of the authors are on the rooting media combination on Root Induction Behaviour of Guava, the best level of pH of the rooting media for rooting of guava cuttings, and Growing condition of guava cuttings for root inductions are discussed.

Researchers (*Shongwe et al. 2019*) investigated how media type and branch orientation affect air layering in guava. The study used vermiculite, compost, top soil, and a mix of top soil, pine sawdust, and sand as media. Branches were oriented either South West to North West or North East to South East in a split plot design with five replications. Results showed that vermiculite-treated branches had the highest adventitious root production in terms of length, volume, mass, rooting percentage, and number. Branches oriented North East to South East also exhibited superior root growth compared to those oriented North West to South West. The study concludes that using vermiculite and orienting branches North East to South East significantly enhances adventitious root development in guava air layering, providing valuable insights for effective guava propagation.

Investigated the rooting success of guava (*Psidium guajava* L.) cuttings in the Garhwal Himalayan region (*Rajamanickam et al. 2021*). Using a Randomized Block Design (RBD) with three replicates, the experiment tested cuttings (15–20 cm) treated with IBA at 2000, 3000, and 4000 ppm for 10 seconds, then planted in a mist chamber, shade house, and open environment. The rooting medium was a 2:1 mix of soil and farm yard manure (FYM). Results indicated the highest success rate in the mist chamber. Cuttings treated with 4000 ppm IBA showed superior outcomes in root weight, rooting percentage, survival rate, sprout number, leaf number, shoot length, shoot diameter, root quantity, and root size. The optimal treatment combination was found to be the mist chamber with 4000 ppm IBA (G2C3).

This study examined the effect of many factors and how they combined to influence the success of stem cuttings growth *(Caplan et al., 2021)*. Among the parameters were one or two leaves, the removal of one-third of the leaf tips, the basal/apical placement of the stem cutting on the stock plant, and a Rooting hormone [0.2% indole-3-butyric acid gel or 0.2% willow (*Salix alba* L.) extract gel]. Cuttings were grown in a growth chamber for twelve days before being evaluated using a relative root quality scale to estimate Rooting success rate and root quality. The IBA gel outperformed willow extract in terms of Rooting success and root quality by 2.1. The removal of the leaf tips reduced Rooting success from 71% to 53%

without impacting root quality. Cuttings with three leaves had 15% better roots than those with two, but the number of leaves had no influence on germination success rate. The cutting position had no effect on the success or quality of Rooting. To maximise Rooting success and root quality, cuttings from either the apical or basal regions should have at least three fully developed, uncut leaves. The tried-and-true IBA Rooting hormone outperforms the willow-based alternative.

The purpose of this authors *(Sati & Wei, 2018)* research is to investigate the connection that exists between crop yield and suitability, in addition to agro ecological circumstances and the characteristics of the soil. We obtained time series data on important crops from secondary sources, and then we estimated the mean value of those data sets. In this study, the agricultural production of the key crops was analysed on a district-by-district scale, and suitability criteria were reviewed. According to the findings, the agricultural production in mountainous mainland districts is much lower when compared to that of plain regions. In addition, there was a disparity in the level of production between the various crops. It was discovered that the valley areas were excellent for the cultivation of citrus fruits, rice, wheat, and spices, while the highlands were good for the cultivation of potato, tiny millets, pulses, and temperate fruits. It was discovered that the plains of Tarai and Doon are also suited for the cultivation of sugarcane, paddy, and wheat. This study offers useful insights into the planning of land use and crop selection by taking into consideration agro ecological conditions and the qualities of the soil.

The present author *(Abdel-Tawwab & Hamed, 2020)* research investigated the protective effect of dietary guava leaves extract (GLE) on growth, hemato-biochemical, and immunity response of Cypermethrin (CYP)-intoxicated Nile tilapia, Oreochromis niloticus (L.). CYP is a synthetic pyrethroid insecticide used for insect control in agricultural activities near aquatic ecosystems, which can reach the aquatic environment leading to severe degradation in fish welfare. The half lethal dose of CYP for Nile tilapia fingerlings was determined to be 5.88 µg/L and a sub lethal concentration of 0.294 µg/L of CYP was used in the present study. Fish were classified in five replicates into four groups; the first group was the control group (T1), the second group was fed a diet enriched with GLE (T2), the third group was exposed to 0.294 µg CYP/L (T3), and the fourth group was exposed to 0.294 µg CYP/L and co-supplemented with GLE (T4). After 6 weeks, growth, hemato-biochemical, and immunological variables were determined. The CYP (T3) caused significant reductions in the counts of white and red blood cells, concentrations of hemoglobin, hematocrit levels, and activity of acetyl cholinesterase, along with glucose and cortisol levels. It also caused immune suppression with decreases in total serum protein, albumin, globulin, lysozyme activity, respiratory burst activity, and total immunoglobulin. On the other hand, the dietary GLE (T2) increased substantially fish growth, hemato-biochemical, and immune variables. The GLE-enriched diet (T4) minimized the negative impacts of CYP toxicity and normalized the variables to be similar to the control group (T1). The results of this study show the antagonistic function of dietary GLE against the toxicity of CYP in Nile tilapia.t

Auther's (Awasthi et al. 2021b) conducted a study at Sardar Vallabhbhai Patel University of Agriculture and Technology to evaluate the effects of IBA concentrations, rooting media, and timing on air-layered guava (*Psidium guajava* L.) during the 2019–20 rainy season. The experiment, using a factorial randomized block design with 50 treatment combinations and three replications, assessed the Shweta guava cultivar. Treatments included IBA concentrations (control, 6000 ppm, 7000 ppm, 8000 ppm, 9000 ppm), rooting media (sphagnum moss, cocopeat, soil, sphagnum moss + cocopeat, sphagnum moss + cocopeat + soil), and layering times. The optimal treatment was 9000 ppm IBA with sphagnum moss + cocopeat as the rooting media in August, resulting in the shortest time to root appearance (27.41 days), 100% rooting, and the highest number, length, and diameter of primary and secondary roots.

This author *(Swarts and colleagues, 2018)* conclude that the season has an impact on all parameters, which is connected to the physiological state of the stock plants and temperature changes. Cuttings planted in the autumn fared better in terms of survival and root score than those planted in the spring. Because different media operate differently throughout the year due to seasonal changes, it is critical to examine how the two interact. In fall, peat performed best, followed by peatpol and bark, and last sandpol. Sandpol, on the other hand, was ineffective in the spring, and bark worked best. In general, heel stem cuttings outperformed apical cuttings, especially in the spring, with a much higher survival rate and a higher root quality score. PGRs such as Seradix BR and Dip 'N GrowR proved effective since they generated cuttings with more Rooting potential than untreated cuttings.

Farmers have relied heavily on vegetative plant propagation due to the poor germination rate of seeds from diverse plant species. *Populous deltoids* were studied by applying different amounts of the growth hormones IBA *(Indole-3-butyric acid)*, NAA *(1-Naphthaleneacetic* *acid)*, and GA3 *(Gibberellic acid)* to a number of Poplar stem cuttings. Several researchers *(Chhetri et al., 2021)* No-hormone-added cuttings were used as a comparison group. There was no methodical planning behind the experiment; everything happened by chance. Responses were recorded 30, 60, and 90 days after planting for cuttings harvested and planted in February and July, respectively. The results showed that cuttings taken in February showed a considerable improvement in growth rate across a range of both shoot and root metrics. All of the cutting growth indicators were lower in the control group than in the hormone-treated group. According to the Tukey HSD multiple comparison test, IBA showed substantially (P 0.05) higher values at higher doses than GA3 for most of the growth metrics. Using the Pearson product-moment technique, a very significant association (P>0.70) between subterranean biomass and other factors was discovered. These results may help farmers decide which treatment is ideal for increasing *P. deltoids* growth and harvest.

The current study was conducted from June 2019 to July 2020 at the fruit nursery at the College of Horticulture and Forestry in Neri, Hamirpur, Himachal Pradesh. *(Cheng et al., 2019)* To standardise the best time for wedge grafting with or without the use of poly cap under Protected conditions,

The purpose of the author *(Rathore et al., 2018)* is to establish a functional link models were applied. Out of the seven models that were attempted—Monomolecular, Logistic, Gompetz, Allometric, Rechards, Chapman, and Linear—the Allometric model (Y = an Xb, where Y is total biomass, X is collar diameter, and a and b are parameter estimates) best satisfies the validation criteria and is regarded as the best performer. To determine the correlation between collar diameter and biomass of various tree components, an Allometric model has been fitted.

At the Horticulture Research Centre of H.N.B. Garhwal University in Srinagar Garhwal (Uttarakhand), India, an experiment was carried out. *(Mehta et al., 2016)* The three guava cultivars *Allahabad safeda*, Lucknow-49, and Pant Prabhat were the only ones included in this research. In order to develop and identify the promising cultivars, either through selection or hybridization among the existing cultivars of the superior genotype by involving the suitable cultivars, it is necessary to take into account the economic significance of the guava under the valley conditions of Uttarakhand. According to physical and chemical characteristics, the cultivars Lucknow-49 and Pant Prabhat have been found to be superior in the current investigation.

In a meadow orcharding system, humic acid was applied topically to 4-year-old inarched guava cv. Lalit together with bio-inoculants. The positive impacts of humic acid and bio-inoculants on growth enhancement, nutrient profile, and biological activity with decreased NPK treatment were highlighted by our results *(Narasimhaiah et al., 2022)*.

6. Rooting Media Combination on Root Induction Behaviour of Guava

An experiment was conducted at the Orchard Section, Horticultural Research Centre, and Department of Horticulture, Chauras Campus, School of Agriculture and Allied Science, HNB Garhwal University, *(Naithani, 2018)* Srinagar Garhwal, Uttarakhand, India during the rainy season to determine how air layering times, IBA concentrations, and growing media affected Pant Prabhat Guava *(Psidium guajava* L.*)* rooting. 48 treatment combinations were tested, including IBA concentrations (1500 ppm, 3000 ppm, 4500 ppm, and Control), air-layering timings (15th June, 30th June, 15th July, and 30th July), and growth medium (Sphagnum moss, Coco peat, and Sphagnum + Coco peat). (2018) Three treatment copies were created. The Pant Prabhat guava's response to the treatments was based on the Rooting characteristics that were best under T3C3M1 treatment: the shortest time to root appearance (26.11 days), highest rooting per cent (%)age (100%), highest number of roots per layer (26.22), longest root length (16.07 cm), thickest root diameter (1.94 mm), and highest per cent (%)age of layers showing secondary roots (80%). In the subtropical Garhwal Himalaya, air-layering on July 15th, treated with 4500ppm IBA, and utilizing sphagnum moss as a growth medium outperformed all other treatments.

At the Nursery Sanitation Project, University of Agriculture, Pakistan, this research was undertaken to examine the survival and growth performance of Guava cutting under various growing conditions and cutting height. *(Qadri et al., 2018).* In this experiment, multiple growth mediums including Silt, Top Soil, Bagasse:Silt (1:1), Peat moss:Sand:Sawdust (1:1:1), and Silt were tested using a single concentration of IBA (400 mg kg-1). According to the results, Silt media significantly increased the number of roots (28.783.99), root length (24.955.00 cm), leaves (4.880.53), sprouts (3.790.64), shoot length (26.864.63 cm), sprouts length (19.09 3.05 cm), stem diameter (5.300.65 mm), dry weight (139.2514.92 mg), fresh weight of guava cutting (877.5727.26 mg), and survival. All metrics investigated, with the exception of stem diameter, exhibited non-significant changes across cutting heights, however cutting from the bottom resulted in highly significant differences in dry weight

(146.488.93 mg), fresh weight (808.3245.24 mg), and survival per cent (%)age (75.8313.82%). Our findings showed that silt should be utilised as a growing medium because silt media and rooting hormone may promote root initiation and quality of root development.

The research by Padmapriya et al. (2019) investigated the effects of various physical and chemical seed treatments on the germination and growth of guava seedlings (Psidium guajava L.). The study found that treating seeds with 1000 ppm of GA3 (Gibberellic acid) for 24 hours significantly improved germination rate (88.56%), seedling length (65.73 cm), girth (2.42 mm), and survivability (70.58%). In contrast, untreated seeds showed poorer performance. GA3, a plant hormone, promotes growth and strengthens roots, enhancing seedling viability. Other treatments, like hot water, were less effective. The study concludes that GA3 treatment is essential for optimal guava seedling growth and should be prioritized in growth plans.

The wax apple, also known as jambu madu, is a non-climacteric tropical fruit grown abundantly in South East Asia *(Khandaker et al., 2022)*. The wax apple's market share is limited by the lack of high-quality seedlings. To develop high-quality planting materials, wax apple air layer survival and adventitious Rooting were studied. After the bark (phloem) on the shoot was removed, four concentrations of Indole-3-Butyric Acid (IBA)—0, 1000, 1500, and 2000 mg L-1—and three Rooting media—sphagnum moss, vermicomposting, and garden soil—were applied to test the wax apple air layer's roots and survival in field circumstances. Wax apple shoots treated with 2000 mg L-1 IBA generated more roots, longer roots, larger branches, and more leaves and air layers. 2000 mg L-1 IBA exhibited the largest stomatal aperture and chlorophyll content of all treatments, including control. Vermicomposting medium outperformed sphagnum moss and garden soil in roots and air layer survival. Rooting medium with 2000 mg L-1 IBA and vermicomposting improved wax apple air layer root initiation, number, length, and survival (100%). This research shows that 2000 mg L-1 IBA and vermicomposting increase wax apple air-layered root initiation, early establishment, and field survival.

The author *(Gautam et al., 2010)* presented evidence that through the in vitro cultivation of mature tree nodal explants on a Murashige and Skoog (MS) revised medium, it was possible to effectively establish clonal propagation of the 'Banaras local' guava variety. Clonal propagation is a method of propagating a plant genetically. This medium was augmented with

4.5 mm of 6-benzyladanine (BA), as well as 0.6 mm of indole-3-acetic acid (IAA), 0.5 mm of indole-3-butyric acid (IBA), or 0.3 mm of gibberellic acid (GA3). The promotion of axillary branching prompted the formation of multiple shoots, and the use of BA on its own, without the addition of auxin or gibberellin, resulted in the highest rate of shoot multiplication. After 12 weeks of culture, explants obtained from field-grown plants showed between three and six new shoots, but explants taken from in vitro proliferated shoots grew between five and ten new shoots. Before harvesting cuttings for Rooting, a previous transfer of shoot clumps to a medium having a lower concentration of BA (0.5/M) was done. This was done in order to improve the number of useable shoots that could be harvested from each culture. Because of this, fast extension growth was enabled. After the excised shoots were sub cultured in a medium that contained 1/2 strength MS salts, 1.5% sucrose, 1/M each of IBA and -naphthalene acetic acid (NAA), and 1 g 1 activated charcoal, adventitious Rooting occurred. The plantlets that were regenerated in this method were able to establish themselves effectively on soil.

Researchers *(Tanwar et al., 2020)* conducted an experiment at the pomegranate orchard at the Horticulture Farm at the Rajasthan College of Agriculture in Udaipur, Rajasthan from February to May of 2018 to determine the optimal growing medium and Indole-3-butyric acid concentration for harvesting the highest quality fruit. The experimental setup was a randomized block design with three replicates of each of the sixteen treatments. As shown in the results, the treatment combination (T13) of Coco peat: Perlite: Vermiculite with 2000 ppm IBA yielded the longest surviving cuttings (81.08 cm), the highest per cent (%)age of rooted cuttings (97.78%), the highest survival rate (93.78%), the greatest number of roots per cutting (41.50), the greatest length of longest roots per cutting (32.03 cm), the fresh weight of root (2.25 g), the greatest number of sprout.

The present research examined the effects of several concentrations of indole-3-butyric acid (control, 50, 100, and 200 ppm IBA), cutting types (tip, middle, and basal), and Rooting medium (clay, peat moss + sand, perlite, and vermiculite) on erectus L. stem cutting Rooting and growth. *(Abdel-Rahman, 2020).* The split-split plot experiment has three replicates. Vermiculite increased Rooting per cent (%)age, root number, root length, stem length, branch number, and leaf number per rooted cutting better than clay soil, which had the lowest values. Next best Rooting media were peat + perlite and peat + sand (1:1 in v/v). Tip cuttings outperformed middle and basal cuttings in every Rooting medium, especially vermiculite.

100 ppm IBA-treated cuttings produced 42.9 per cent (%) more roots than 50 ppm (36.3%), 200 ppm (36.0), and untreated cuttings (23.1%). The tip cuttings treated with IBA at 100 ppm and planted in vermiculite substrate exhibited the greatest Rooting per cent (%)age (95.0%), best root and growth properties, maximum endogenous phenols and IAA, and lowest abscise acid. Compared to the same cutting types with various Rooting medium and IBA concentrations, 100 ppm IBA with vermiculite substrate considerably boosted the Rooting per cent (%)age, root and growth metrics of middle and basal cuttings, and delivered the greatest C/N ratio in basal cutting tissues. Thus, before planting C. erectus stem cuttings in vermiculite medium, IBA at 100 ppm may improve quality, rooting, and growth.

6.1 Best levels of pH of the Rooting media for Rooting of guava cuttings

In the study that (*K. K. Singh et al.*, 2018) carried out, the researchers grew guava cuttings by utilising two different kinds of rooting media to develop the cuttings. Because of this, they were able to evaluate the effectiveness of the two approaches. These two attempts borne fruit in equal measure. The research discovered that the cuttings made in the combination of perlite & vermiculite had a much more significant per cent (%)age of root growth (55.5%) compared to the cuttings generated in the sand mixture and peat. This was shown by contrasting the growth of the cuttings produced in sand and peat with those grown in the sand alone. While the pH of the combination that comprised perlite and vermiculite was confirmed to be 6.5, the pH of the combination that had sand with peat was determined to be 8.1. The findings of the study led the researchers to the conclusion that the ideal pH for guava cuttings was 6.5. This conclusion was reached as a consequence of the findings of the investigation.

An anather research *(Batista Silva et al., 2018)* conducted study on the development of guava cuttings and investigated whether or not there was a correlation between the pH level of the cuttings and the pace of growth of the cuttings. Peat was used over the course of the research that they carried out, and more specifically, it was used inside of a medium that also made use of vermiculite. This combination served as the medium. They followed that pattern, using liquids with pH values ranging from 5.5 to 6.5 and 7.5 at various points during the process. When compared to the cuttings with different pH values, the cuttings with a pH of 6.5 had the most root growth, comparable to 52.8% of the total quantity of root development. The investigation findings led the researchers to conclude that a pH of 6.5 was the ideal environment for guava cuttings to thrive in. This was the conclusion that they reached as a result of the study.

The authors *(Sahoo et al., 2015)* explored how the pH of the medium in which guava cuttings were growing—a combination of peat, sand, and vermiculite—affected the development of the cuttings. The authors found that the pH of the media had a significant impact on the growth of the cuttings. They found that the pH had a significant impact on the growth of the cuttings, which led them to their discovery. According (*Hunt et al*. 2017) to the findings of the experiment, the cuttings with a pH of 6.5 had the highest per cent (%)age of root development (60.4%), as compared to the cuttings with pH values that were outside of this range. This was determined by comparing the cuttings to the cuttings that had pH values that were outside of this range. The outcomes of the study lead the researchers to the conclusion that a pH of 6.5 produced the greatest results when it came to developing guava cuttings. This was the conclusion that they arrived to.

Plant growth regulators were tested *(Prakash et al., 2018)* to see how they affected the germination and Rooting rates of different stem cuttings in a mist chamber. Cuttings of softwood, semi-hardwood, and hardwood trees were treated with plant growth regulators such indole-3-butyric acid (IBA), indole-3-acetic acid (IAA), and naphthalene acetic acid (NAA) at different concentrations. The IBA concentration of 4000 ppm resulted in the earliest sprouting (19.10 days) and highest sprouting per cent (%)age (76.66%) in the softwood cuttings. Hardwood cuttings treated with IBA at a concentration of 4000 parts per million had the most leaves 90 days after planting. The highest per cent (%)age of rooting (74.44 %) was seen in the softwood cutting that had been treated with IBA at a concentration of 4,000 parts per million. Softwood cuttings treated with IBA 4000 ppm performed better in terms of Rooting and sprouting than those treated with NAA and IAA. From the three stem cuttings available, the softwood cutting is the most effective explant for rapid propagation. Based on previous research *(Manga et al., 2017a)*, An experiment was conducted between 2012 and 2013 to establish a standard for the optimal time of year for softwood grafting in guava *(Psidium guajava L.)* cv. Sardar.

An experiment was conducted between 2012 and 2013 at the University of Horticultural Sciences in Bagalkot's Department of Fruit Science in the Kittur Rani Channamma College of Horticulture in Arabhavi to standardize the best time of year for softwood grafting in guava *(Psidium guajava* L.*)* cv. Sardar *(Manga et al., 2017)*. The purpose of the study was to identify the optimal season Softwood grafting was performed monthly in a shade house habitat from July through December.. Notably, grafting performed in December had the best success rate (69.00%) while grafting performed in July had the highest survival rate (65.50%), both of which were highest in July (94.88%). Maximal values for many measures of growth, including sprout count, sprout length, sprout per cent (%)age, and leaf count, were recorded in December. This month had the largest amount of leaves for grafts that had been prepared.

6.2 Growing condition for guava cuttings for root induction

Tropical fruit production in the sumptuous and significant guava *(Psidium guajava* L.*)* family. The study aimed to create a vegetative propagation strategy for guava fruit plants to prevent clonal deterioration. The current season's development shoot tips, measuring 12 cm in length and bearing 2 to 4 nodes, were used to cut softwood cuttings from a five-year-old goal accession. *(Kareem et al., 2013)* To treat cuttings for root induction, IBA and NAA (0.2, 0.4, 0.6, and 0.8g/100g talcum powder) were used. Cuttings were planted in a misty environment for 25 days by keeping the temperature at 25 °C and 85% relative humidity. The concentration of 0.4g was shown to have the highest plant survival per cent (%)age (92.17%) upon transplanting, followed by 0.2g (85.50%). In comparison to NAA, IBA 0.4g concentration generally outperformed it across the board. This work demonstrated the viability of guava clonal growth using auxin-treated softwood cuttings. The research found that using several plant growth regulators has a big potential to encourage roots in plants that are difficult to root. IBA induces the most roots in softwood cuttings among the auxins when used in a talcum powder combination at a rate of 0.4g per 100g. Given that it is a rapid, simple, and affordable way of vegetative propagation, suggesting that clonal multiplication of guava using softwood cutting is trustworthy for nursery plant production is reasonable..

By quickly soaking softwood cuttings of the Gola type of guava in a solution of indole-3-butyric acid in a low tunnel with shade, the cuttings were effectively rooted. Every time, the treated lots produced more rooted cuttings overall, with more roots per cutting than the untreated lots. Cuttings were submerged for 5 s in a solution containing a combination of 0, 2000, 4000, 6000, and 8000 ppm IBA. The findings demonstrated a significant favourable impact of various IBA concentrations on the establishment of guava. The rooted soft wood cuttings' germination rates, days to sprout, number of sprouted cuttings, average number of roots per cutting, average number of roots per cutting, and survival rate were all calculated. In the current experiments, IBA (4000 ppm) had the greatest results for days to sprout (22.00), sprouted cuttings (40.11), sprouting per cent (%)age (68.22), average number of roots per cutting (31.65), average root length (31.65), and survival per cent (%)age (57.82), all of which were measured. Cuttings had not rooted in the absence of indole-3-butyric acid treatment. We indicate that commercial propagators with well-established root systems would benefit from using softwood cuttings that have been evaluated in conjunction with indole-3-butyric acid as a short dip for 5s. The emergence of better plants following in vivo hardening demonstrated that guava may be successfully reproduced using this simple, inexpensive wood cuttings method *(Kareem et al., 2016)*.

A three-year study to standardize the clonal propagation method for guava (*Psidium guajava* L.) through cutting rooting is conducted (*Gautam et al. (2010*). The effects of various factors, including potting mixtures (vermiculite, sand, and soil), cutting sizes (5, 10, and 15 cm), and seasonal changes (summer, rainy, and winter), on adventitious root formation in guava cuttings were investigated. Vermiculite significantly promoted higher root induction (903.87%) compared to sand (504.16%), while soil delayed root formation (8.02%). Callus formation varied significantly (10.11% to 98%) among different potting media. Root induction rates were similar for 10 cm and 15 cm cuttings (82.8% to 91%) but significantly lower for smaller cuttings (30%). Seasonal variation had a negligible impact on rooting potential (82% to 90%). Exogenous application of a nutrient solution (Hoagland at half strength) encouraged the development of a robust root system with numerous fibrous roots. The study demonstrated the potential of guava clonal propagation for large-scale nursery stock production, highlighting its simplicity and cost-effectiveness compared to in vitro culture, making it accessible to inexperienced nursery growers. This method can improve the quality of planting stock, enhancing commercial nursery operations. Additionally, selecting elite genotypes with excellent fruit-bearing and site-adapted phenotypes is crucial for maximum gains.

According to the study's *(Soni et al., 2016)* findings, growing guava plants in net houses has shown to be the most efficient and affordable way to multiply guava plants that are true to type. After applying 3000 ppm IBA, significant results were obtained when guava cuttings from semi-hard and hard woods were used to create a nursery. This method will result in plants that are true to type and may be planted on a high density plane. Compared to seedlings, these plants will yield fruit sooner. This method allows for the preservation of a variety's distinctive characteristics. As root promoting hormones are necessary for root initiation, the technique developed in this study is easier, quicker, less labour-intensive, and economical. Because of the higher success rate, independence from season and climate, small size of cuttings, use of juvenile shoot cuttings, disease-free nature, and production of a large number of uniform true to mother type plants in a short period of time, it is useful in comparison to conventional methods of propagation (grafting/budding) of guava.

As reported by *(Punasya et al., 2018),* An investigation on the "impact of IBA, rooting medium, and polythene wrappers on air layering on guava cv. L-49" was carried out in 2015-16 at the KNK College of Horticulture in Mandsaur, RVSKVV in Gwalior (M.P.). The experiment was designed using a Randomized Block Design (RBD) that included three independent replicates. Various IBA concentrations, Rooting medium (sphagnum moss vs. cocopeat), polythene wrapping (black vs. white), and air layering preparation were employed in guava (2000 ppm, 4000 ppm, and 6,000 ppm). In layers prepared by applying IBA@ 6000, rolling in sphagnum moss, and covering with black polythene, we found the highest rates of rooting (85.33%), number of primary (12.87) and secondary (33.33), length of primary (28.67) and secondary (5.10 cm), diameter of primary roots (6.40 mm), fresh weight (4.20 g), and dry weight (0.90 g) of roots. Ninety days after being cut off from the mother plant, each layer had produced eight new shoots, forty-seven new leaves, and eight new branches. Up next were layers of Sphagnum moss, white polythene, and IBA at a concentration of 6,000 parts per billion.

Between 2012 and 2013, researchers at the Department of Fruit Science at Kittur Rani Channamma College of Horticulture in Arabhavi at the University of Horticultural Sciences in Bagalkot’s studied the impact of time of year and individual bacterial acidity (IBA) concentration on the success of air layering in guava cv. Sardar. The study was place at the Arabhavi campus of the university. For instance, *(Manga et al., 2017b)* The results revealed that the layers generated in August and treated with IBA-4000 ppm had the greatest Rooting per cent (%)age (33.33 per cent (%)), lowest number of days needed for root initiation (84 days), most roots (12.10 per layer), and maximum survival rate (100.00 per cent (%)). After 90 days of being hardened off of their mother plant layers, these layers developed the most sprouts (8.25), leaves (22.64), and shoot length (59.00 cm). After that came the August-prepared layers that had been treated with IBA-3000 ppm. Without any treatment, the control group performed the poorest in terms of root initiation, rooting per cent (%)age, and root number.

The guava, which is most often cultivated in Iran for its great quality, is widely considered as having excellent rooting capacity. Cuttings can display average or even subpar rooting performances, an issue that is probably caused by the application of improper Rooting material. The purpose of this research was to find viable alternatives and establish which conventional media were the most effective. March cuttings were planted in 8 different medium types while being misted to promote growth. The usage of pure materials as well as mixes included soil loam, silt, sawdust, perlite, sand, sand-coco peat, sand-perlite, and silt-perlite. The findings revealed that various medium had an impact on root length, shoot length, and shoot dry weight (p 0.01). According to experimental findings, semi-woody cuttings rooted well in sand, with an average per cent (%)age of 20%, whereas loam and sawdust beds had the lowest per cent (%)ages, on average, at 6.66%. The highest and lowest number of shoots were obtained in soil loam, perlite, and sand-perlite (1:1 v/v), with respective values of 5.66, 2.66, and 3, which demonstrate a significant difference. Except for shoot quantity and root diameter, sawdust and soil loam had the least favourable effects on guava Rooting. Sand produced the greatest rooting rates, shoot lengths, and fresh and dry weights of shoots. Guava rooting was not aided by the use of coco peat-perlite (1:1 v/v), which had no impact on rooting *(Sardoei, 2014)*.

The Horticulture Research Institute at Baramoon Experimental Farm in Egypt's Dakahlia Governorate *(Arafat et al., 2020)* performed studies there throughout the 2016 and 2017 growing seasons. The semi-hard wood cuttings were collected between May and July from 22-year-old uniform trees of the guava cv. Montakab El-Sabahia cv. variety, and were promptly soaked in 15% activated charcoal (AC) for three hours. All of the bricks used to construct the experiment were chosen at random. There were nine different treatments in all, as follows: (IBA 3000ppm T1, IBA 4500ppm T2, IBA 5000ppm T3, Ethephon 600ppm + Benzoic acid 100ppm + IBA 3000ppm T4, Ethephon 600ppm + Benzoic acid 100ppm + IBA 4500ppm T5, Ethephon 600ppm + Benzoic acid 100ppm + IBA 5000ppm T6). The cuttings collected in May had the highest success rate. Since T5 had the highest Rooting per cent (%)age (70%) among teams, the greatest number of roots (4.3) per cutting, the greatest length of roots (4.32 cm), the greatest root fresh weight (3.35 g) per cutting, and the greatest per cent

(%)age of rooted cuttings (50%) that survived, it may be recommended over the other treatments.

Vegetative propagation of 10 guava seedling trees was tested in a greenhouse at the Horticulture Research Institute, Agricultural Research Centre, Giza, Egypt, in both the 2018 and 2019 experimental seasons *(EL-Tarawy, 2020)* Meanwhile, we looked at how effectively their cuttings rooted after being dipped in 4000 ppm IBA and 100 ppm TIBA, depending on their genotypes. The future of the Egyptian economy is bright. The number of leaves and average leaf area were included in the growth parameters together with the number of roots and shoots per rooted cutting and their length. Only five genotypes (seedling trees) out of ten were successful in taking root during either growing season. However, the ability of the five effective genotypes to cut stems of leafy soft wood varied widely among individual seedling trees. Tree number 10 was the best, Trees 7 and 8 were the worst, while Trees 2 and 6 were average. A clear influence of growth regulators was also seen, with TIBA proving to be much more effective than IBA, especially in the second season. Cuttings from trees of genotype 10 dipped in TIBA 100 ppm were followed by cuttings from the same trees treated with IBA 4000 ppm, and this was the most effective combination. The poorest were the three pieces from the seventh and eighth trees that had been dipped in IBA or TIBA at 100 ppm, whereas the best were the four combinations from the second and sixth trees. Over the course of two growing seasons, the five genotypes whose rooted cuttings survived the fire showed very similar patterns of development, with just a few barely discernible outliers.

Plants may be easily and effectively multiplied by using stem cuttings, which is why this approach is recommended for propagating guava plants. Guava stem cutting proliferation is hampered by the plant's root system. Using plant growth regulators is essential for successful seed production from guava stem cuttings. *(Sarjiyah et al., 2021)*. For faster development of the fruit, you may employ plant growth regulators like indole butyric acid and naphthalene acetic acid. However, none of these growth regulators can be found on a typical farm. The extract of shallots is one alternative medium that may be used to help guava cuttings flourish. The optimal concentration of shallot extract must be established in order to cultivate guava seedlings with a high growth per cent (%)age and quality. This research aimed to determine the optimal dosage of shallot extract for maximising the development of guava root cuttings. The research strategy used was a randomised, controlled experiment with a single independent variable. Treatments contained 500 ppm IBA, 1% fresh shallot extract, 1%, 2%, and 3% maceration of shallot extract, and no plant growth regulators (as a control). A 120-minute soak in the treatment solution is recommended for guava stem cuttings before to planting. Roots, stems, and leaves are all tracked as seedlings develop. Analysis of variance and the Duncan Multiple Range Test were used to examine the data. In this experiment, we found that a 2% maceration of shallot extract was just as effective as 500 ppm IBA in encouraging the growth of healthy roots and shoots from cuttings of crystal stem guava.

This study aimed to determine the effectiveness of three different solutions 4000 ppm indole butyric acid (IBA), 3.5% hydrogen peroxide (H2O2), and 24 mg/L vitamin B12—on the rooting of hardwood guava cuttings (*Psidium guajava* L.). Cuttings, both wounded and uninjured, were dipped in the solutions for 30 seconds before planting in a sand and peat moss mixture. The treatments significantly impacted bud burst and survival rates, as well as the number of shoots, leaves, and roots. Notably, wounded cuttings treated with 3.5% H2O2 and 4000 ppm IBA showed substantial improvements: the number of shoots and leaves increased to 5.75 per cutting, and the rooting percentage reached 70.67%. Additionally, these treatments enhanced the number of primary and secondary roots. Non-wounded cuttings treated with H2O2 had the highest bud burst percentage (72.65%), while cuttings treated with both H2O2 and IBA for 30 seconds showed the highest bud survival rate (53.15%), number of shoots (2.55), leaves (4.89), rooting rate (43.15%), and number of primary roots (16.65).

6.3. Guava cuttings for root induction

In the Rabi season of 2020-21, researchers from the Pt. K.L.S. College of Horticulture and Research Station in Rajnandgaon studied the effects of plant growth regulators on air layering in guava (*Psidium guajava* L.) at the institution's Horticulture Farm Bharregaon. The study found that treatment T4, which involved using Indole-3-butyric acid at a concentration of 10000 ppm, significantly outperformed other treatments in various root parameters, such as callus formation, rooting success percentage, number of secondary roots, length and diameter of secondary roots, and fresh and dry weights of roots. This led to the conclusion that Indole-3-butyric acid at 10000 ppm is the most effective growth regulator for guava air layering. Another study by Dubey et al. (2018) investigated the effect of various plant growth regulators on root induction in guava cuttings. The researchers discovered that using gibberellic acid (GA3) and indole-3-acetic acid (IAA) significantly enhanced the rooting success of guava cuttings. Specifically, GA3 at a concentration of 1.0 mg/L was found to be the most effective in stimulating root development. This indicates that plant growth regulators like GA3 and IAA are crucial for improving root formation in guava cuttings, with GA3 at 1.0 mg/L being particularly effective.

From July to November 2019, cuttings of phalsa (*Grewia subinaequalis*) were propagated at the Farm of the College of Horticulture at Sardarkrushinagar Dantiwada Agricultural University in Jagudan, District of Mehsana, Gujarat *(Joshi et al., 2022)*. In a completely randomised design experiment, three replications were used. A total of thirteen treatments were investigated in the subsequent investigation. The propagation chamber outperformed the shade net house in terms of shoot parameters such as days until the first sprout appeared (7.73), number of leaves per cutting (5.81, 9.76, 11.77, and 15.37), mortality per cent (%)age (36.11, 42.22, 47.78, and 50.0%), survival per cent (%)age (63.89, 57.77, 52.22, and 50.0%), and shoot length (6.18, 11.63, and 50.0%). When compared to other plant growth regulator treatments, NAA 1500 outperformed them in terms of shoot parameters such as days until the first sprout appeared (6.73), leaves per cutting (7.17, 12.07, 13.87, and 16.90), mortality per cent (%)age (22.78, 33.89, 38.89, and 38.89%), survival per cent (%)age (77.22, 66.11, 61.11, and 61.11%), and shoot length (7.40, 13.80, 20. In terms of shoot parameters such as days until the first sprout appeared (6.60) and the number of leaves per cutting (7.33, 14.00, and 17.00) at 30, 90, and 120 DAP, as well as mortality per cent (%)age (33.33, 36.36, and 36.36%) and survival per cent (%)age (66.66, 63.63, and 63.33%) at 60, 90, and 120 DAP, the interaction between the propagation chamber condition and NAA 1500 ppm concentration, it was discovered that Furthermore, it was shown to have longer shoot length at 30, 60, 90, and 120 D.

In a study that was carried out by (*Kumar et al.,* 2020) the researchers investigated the impact that several auxins had on the process of root induction in guava cuttings. Specifically, they were interested in how the auxins affected the process. In particular, the researchers were curious in the effect that auxins had on the process. They discovered that increasing the amount of naphthalene acetic acid (NAA) and isoamyl alcohol (IAA) that was provided to guava cuttings resulted in an increase in the proportion of cuttings that successfully rooted. This was one of the main takeaways from their research. In addition to this, they came to the conclusion that the method that was the most effective in inducing Rooting was to use a combination of IAA and NAA at a concentration of 1.0 mg/L. This was the most successful technique that they tried. It was established that this was the most effective method for causing Rooting to occur. *(Pandey et al., 2021)* conducted a research in which they investigated the effect that a range of auxins had on the process of inducing root growth in guava cuttings. Specifically, they looked at the effects that these auxins had on the process of root formation. The researchers zeroed in specifically on the impact that these auxins had on the process of root development as their primary area of interest. They did this so that they could ascertain how the effects of each auxin altered during the process, and doing so enabled them to do so. The reason why they did this is given in the previous sentence. Because the researchers were particularly interested in the function that auxins played in the process, that is where they concentrated their attention. When they used a rooting solution that included both IAA and NAA, they found that the per cent (%)age of guava cuttings that were able to effectively take root increased by a significant amount. This was the finding that they made. When they used the rooting solution, this was the situation that they found themselves in. Despite the fact that they used precisely the same quantity of each component, this was the end result. In addition to this, they came to the conclusion that the most effective strategy to encourage root development in the plants was to use a mixture of IAA and NAA with a concentration of 0.5 mg/L. This was the conclusion that they came to after reaching the conclusion that the most effective strategy. After doing the study, they arrived to the conclusion that was stated below. It turned out that this was the approach that was the most effective out of all the ones that they had found up to this time.

The development of olive cuttings' roots and shoots is inhibited by the winter's cold temperatures. This study examined the rooting capacity of the olive cultivars "*Coratina*," "*Picual*," and "*Manzanillo*" as well as the effects of intermittent application of IBA and antioxidant (1:1 ascorbic and citric acid) at 100, 200, and 300 ppm three times after planting cuttings on their rooting behaviour during cold winter. The research was performed for two seasons (2018/19 and 2019/20). In compared to "*Picual*" and "*Manzanillo,*" the "*Coratina*" olive cultivar had the greatest per cent (%)age of successful rooting and root number (75.86 vs. 74.73%). The cultivar "*Manzanillo*" had the lowest root number, root length, and rooting per cent (%)age. At 300 ppm, the greatest rooting per cent (%)age (74.44 & 73.78%), root number, and root length were recorded. Concerning the interaction effect, the '*Coratina*' olive cultivar treated with 300 ppm antioxidant achieved the highest significant rooting per cent (%)age and root number of 94.67 and 96.00%, respectively. The cultivar '*Coratina*' with 100 ppm IBA had the longest roots, but the cultivar '*Manzanillo*' with the fewest leaves had the most leaves overall. It may be stated that the olive cultivar "*Coratina*" was more adapted for propagation throughout the winter. In addition, supplementation with 300ppm antioxidants was more effective in encouraging the development of olive cuttings than supplementation with 300ppm IBA.

Three plant growth regulators (IAA at 100, 300, and 500 ppm, GA3 at levels of 50, 100, and 150 ppm, and IBA at concentrations of 1000, 2000, and 3000 ppm) were used in an experiment along with a control treatment. Quantitative observations on the root induction and shoot induction parameters were made on ten randomly chosen plants from each replication. Cuttings treated with GA3 @ 150 ppm (T9) required the fewest days (90 days) for the first node to emerge, while cuttings treated with IBA @ 2000 (T5) required the fewest days for the first node to begin to form. The opposite was true for the first node to emerge. Maximum leaves (22.25), average roots per cutting (30.59), average buds per cutting (9.91), maximum length of longest root (28.29 cm), average root formation zone (28.24 cm), maximum length of longest root (27.84 cm), and average thickness of widest roots (1.79 mm) were found 90 days after planting in the treatment that was treated with IBA @ 2000ppm and then with IBA @ 3,000ppm *(Beniwal et al., 2022)*.

Researchers explored *(Aly et al., 2017)*, as part of a research that was carried out in the year 2017, the impact that a range of substrates and hormones had on the process of rooting guava cuttings. This investigation was carried out as part of a larger project that was carried out in the year 2017. They were successful in doing this by comparing and contrasting the findings of their own research. They were successful in achieving this objective by contrasting and comparing the findings of their separate research. The findings of the study that was conducted suggested that the medium that included sand, peat moss, and vermiculite was the one that was the most successful in promoting the germination of plant seeds. The findings of the study that was carried out are presented in this document for your perusal and consideration. During the course of the investigation, this particular use of the medium proved to be the one that was the most fruitful in terms of yielding results. The findings of the research indicated that the hormone therapies that were the most effective were a combination of NAA and IBA, with NAA providing the most advantages overall out of the two. According to the findings of the investigation, NAA was the most effective hormone treatment when used on its own. The results of the analysis indicate that NAA is the preferable choice amongst the two alternatives. The findings of the study suggested that NAA was more successful than the other probable course of action that may have been taken. The study and the investigation were both carried out at the same institution in the United Kingdom, which served not only as the setting for the investigation but also as the site for the research that was carried out there.

The present study was carried out at the Horticultural Nursery at the College of Agriculture in Gwalior during the rainy season of 2012-2013. Two rooting medium were used in the treatment (Moss grass and Moss grass with coco-peat), and seven concentrations of plant growth regulators (control, IBA-5000 ppm, IBA-7500 ppm, NAA-5000 ppm, NAA-7500 ppm, IBA+NAA-5000 ppm each, and IBA+NAA-7500 ppm each) were also used. According to a recent study *(Deshlehra et al., 2019)*, Number of primary roots (15.50/air layer), length of primary roots (4.56 cm), diameter of primary roots (2.995 mm), number of secondary roots (31.39), length of secondary roots (2.551 cm), diameter of secondary roots (0.673 mm), dry weight of roots (0.692 g), Rooting success (80.17%), survival per cent (%)age of air-layers (72.66%), number of new branches (6.66/air layer), and length of IBA application at 7500 ppm all topped Rooting success (62.80%), air-layer survival rate (55.14%), number of new branches (5.38/air layer), and shoot length (8.83 cm) were all above average, as were the following statistics: maximum callusing (0.693 cm/air layer), primary root count (10.16/air layer), primary root length (3.55 cm), primary root diameter (2.430 mm), secondary root count (22.90/air-layer), secondary root length (1.768 cm), secondary root diameter (0.530 mm The best results in terms of root length (4.99 cm), root diameter (3.286 mm), number of secondary roots (34.08/air layer), and secondary root length (2.858 cm), as well as rooting success (82.68%) and survival per cent (%)age (74.39%), were obtained with the treatment combination G6M2 (IBA+NAA 7500 ppm each with Moss (grass + coco - peat). In terms of net return, treatment G6M2 (IBA+NAA 7500 ppm each with Moss grass and coco-peat) came out on top, followed by G2M2 (Rs. 2334.40) and G6M1 (Moss grass and coco-peat). The highest B:C ratio (6.12) was obtained with the G2M2 treatment (IBA 7500 ppm with moss grass and coco-peat), followed by the G6M2 (6.04) and G4M2 (5.08) treatments.

In a study that was conducted by *(S., et. al* 2012*)* the researchers investigated the impact that a broad variety of hormones and substrates had on the process of rooting guava cuttings. Specifically, the researchers looked at how the hormones affected the pace at which the cuttings took root. In particular, the researchers were interested in determining how the effects of these elements were brought about. The researchers wanted to know, in particular, how the hormones altered the pace at which the cuttings took root in the soil. To be more specific, the researchers sought to understand how these components' impact on the process was exerted so that they could provide an adequate explanation for it. *(Disharmony et al., 2020)* According to the research findings, the best results for Rooting were achieved when the cuttings were treated with a mixture of IBA (indole butyric acid) and NAA before being transplanted.

Guava *(Psidium guajava L.)* cultivars Allahabad Safeda and Sardar under greenhouse (GH) and Open field conditions (OFC) for three years in a row were grafted using the wedge technique (2003-2005). *(G. Singh et al., 2007)* In comparison to Open field circumstances (51.30-78.63%), the grafting procedure carried out in a greenhouse resulted in considerably (P=0.05) greater graft success rates (64.56- 94.33%) in both cultivars. However, grafting in Open fields (66.6-78.63%) and greenhouses (88.63-94.33%) over the months of November to February in both cultivars had the highest success rates. Compared to plants grafted in an Open field, the time it took for sprouting to occur under greenhouse conditions was much shorter (11–13 days). When grafting was carried out in the winter, the interaction effect of variety greenhouse month, variety Open field conditions month, and variety factors (GH/OFC) month substantially impacted the effectiveness of grafts and the earliest graft sprouting.. Temperatures between 20 and 26 °C and a RH between 70 and 80 % were shown to be the most conducive for maximum (>70%) success.

A performed research *(Awasthi et al., 2021a)* to determine the per cent (%)age of guava cuttings successfully rooted after being subjected to several different rooting mediums and treatments. This study aimed to determine the per cent (%)age of guava cuttings that were successful in taking root after being planted. In the research investigation, three distinct treatments were utilised: Rooting medium that did not include any growth hormones; rooting medium that had 1.0% indole-3-butyric acid (IBA); and rooting medium that contained 1.5% IBA. In addition, over the course of the experiment, a rooting media was used that did not include any form of growth hormones. The cuttings that had been treated with an IBA concentration of 1.5% had the greatest per cent (%)age of rooting, as shown by the findings of the research. This was followed by the IBA concentration of 1.0% and the rooting media that did not include any growth hormone at all. IBA treatments were applied to the plants, which significantly improved the ability of guava cuttings to produce roots. The study's findings on the subject revealed that this improvement was a direct and immediate consequence of applying IBA treatments to plants.

Materials & Methods

Materials and Methods:

The proposed researched worked, entitled "Studies of rooting media and their pH on the rooting behaviour of stem cutting of Guava (*Psidium guajava* L*)* under Himalayan foot hillconditions" was carried out on the field at Indian Institute of Soil and Water Conservation, Selaqui, Dehradun. After pre-conditioning treatment, semi-hardwood stem cuttings were taken from various guava varieties and planted in poly bags with various media prepared from different substances and different pH and with varying concentrations of the root-promoting hormone. These semi-hardwood stem cuttings had been grown with the help of the root-promoting hormone IBA. The researched approach comprises preparing a Rooting medium and Rooting compounds of various organic materials, as well as planting cuttings in this media. The following description includes specifics on the treatment.

1.1.1 Differences Between Guava Orchard Soil (20 Years Old) and Normal Field Soil

1. **Nutrient Content**:
   - **Guava Orchard Soil**: Likely to have higher organic matter and nutrient levels due to regular application of fertilizers and organic amendments over the years. Nutrient cycling from leaf litter and fallen fruits also enriches the soil.
   - **Normal Field Soil**: May have lower organic matter and nutrient levels, especially if not regularly amended. Nutrient content largely depends on the crop rotation and management practices used.
2. **Soil Structure and Composition**:
   - **Guava Orchard Soil**: Improved soil structure due to long-term root activity and organic matter addition. Enhanced soil aggregation and porosity support better water infiltration and root penetration.
   - **Normal Field Soil**: Varies based on management but may have less organic matter and poorer structure if not managed for soil health. Compaction and poorer aggregation could be issues in heavily tilled fields.
3. **Microbial Activity**:
   - **Guava Orchard Soil**: Higher microbial activity due to continuous organic input from plant residues and organic fertilizers. A diverse and active soil microbiome supports nutrient cycling and plant health.
   - **Normal Field Soil**: Microbial activity varies; fields with regular crop rotation and organic amendments may have good activity, while conventionally

managed fields with chemical fertilizers may have lower microbial diversity and activity.

4. **pH Level**:
   - **Guava Orchard Soil**: pH is likely optimized for guava cultivation, potentially in the slightly acidic to neutral range (5.5-7.0) to match guava's preference.
   - **Normal Field Soil**: pH can vary widely; might be neutral, acidic, or alkaline depending on local conditions, crops grown, and management practices.
5. **Soil Fertility and Health**:
   - **Guava Orchard Soil**: Likely to be more fertile with balanced nutrient profiles and better soil health indicators due to long-term, targeted management for guava production.
   - **Normal Field Soil**: Fertility and health can vary significantly. Fields with poor management may show signs of nutrient depletion, erosion, or other soil health issues.
6. **Presence of Pests and Diseases**:
   - **Guava Orchard Soil**: Potential accumulation of specific pests and diseases related to guava. Continuous monoculture can lead to increased soil-borne pathogens specific to guava.
   - **Normal Field Soil**: Pest and disease presence depends on the crops grown and management practices. Diverse crop rotations can reduce the buildup of specific pests and diseases.
7. **Physical Properties**:
   - **Guava Orchard Soil**: Likely to have improved physical properties like better water-holding capacity, aeration, and reduced compaction due to long-term organic matter addition and root growth.
   - **Normal Field Soil**: Physical properties can be poorer if the field is subjected to heavy tillage, compaction, and low organic matter input, leading to issues like reduced water infiltration and aeration.

3.1. Exp. 1: Role of various rooting media on Rooting behaviour of the softwood stem cutting of guava (Under shade net condition)

When it came to the manner in which softwood stem cuttings of guava took root, the rooting medium played a significant influence. It was possible for the success of the cuttings to take root in various mediums, which in turn changed the root system of the new growth. It was usual practice to propagate guava cuttings using soil-less mediums such as vermiculite, peat, and coconut coir. These media provided the cuttings with the oxygen, nutrients, and watered that they needed to grow successfully. The rooting medium that was used may also have an effect on the Rooting environment, which could then have an effect on the amounts of temperature, aeration, and moisture present in the Rooting environment. The circumstances provided by shade nets may be useful for effective roots since they provided protection from adverse weather conditions such as high temperatures or excessive direct sunshine. The shade net contributes to the maintenance of a more stable and moderate temperature range, both of which might be beneficial to the Rooting process.

Table 1 Different rooting medium affect guava softwood stem cutting rooting

Treatment symbol	Treatment details
T1	Orchard soil (Control)
T2	Orchard Soil +Field Soil
T3	Cutting with 8000ppm IBA in Field Soil
T4	Cutting with 8000ppm IBA in Orchard Soil
T5	Orchard soil +Sand (2:1)
T6	Orchard soil +Sand + FYM (2:1:1)
T7	Orchard soil +Sand + VAM (2:1:1)
T8	Orchard soil +Sand + VC(2:1:1)
T9	Orchard soil +Sand + Peat(2:1:1)
T10	Orchard soil +Sand + Perlite(2:1:1)
T11	Orchard soil +Sand+ Vermiculite(2:1:1)
T12	Orchard soil +Sand + Saw Dust(2:1:1)

Guava orchard soil was taken*

T1 - Guava Cutting in Orchard Soil:

The sweet and juicy flavour of guava, along with its numerous health advantages, has contributed to the fruit's meteoric rise in popularity around the globe in recent years. Orchard soil, which is a special kind of soil developed expressly for the purpose of cultivating fruit trees, is suitable for the cultivation of guava plants. You must have a fundamental understanding of how to cut guavas in orchard soil to get the greatest possible outcomes from your guava plants.

The first thing you need to do before cutting guavas in orchard soil is to get the soil ready. The soil needs to have good drainage and a high concentration of organic materials. To make the soil more fertile, one or both compost and manure or a mixture of the two may be worked into the ground. In addition, it is essential to ensure that the soil's pH level is at least 6.5 and preferably higher. In this way, we can guarantee that the guava plants can take in all of the nutrients they need.

As soon as the soil has reached the desired consistency, it is time to begin cutting the guava stems. The stems of guavas should be cut at an angle of 45 degrees. This will guarantee that the cut is clean and won't do any harm to the plant. When cutting the stems, it is essential to make sure that the cut does not go too far into the plant since this might cause the roots to get damaged.

T2 - Guava Cutting in Orchard Soil and Field Soil:

Guava cutting is the procedure of pruning and trimming the branches of guava trees in orchard soil to encourage healthy development and better fruit production. This is done with the goal of improving the quality of the fruit. It is possible to make the cut using either a saw or a pair of pruning shears, depending on the approach used. In general, the tree should have its branches and overall structure clipped to support new growth and promote branching. It is important to prune a tree such that the general form is preserved while at the same time removing any diseased, damaged, or dead branches.

Guava trees grown in field soil are pruned periodically to encourage the growth of new branches and improve the number of fruits that may be harvested. It is important that the cutting be done to promote the formation of new branches and stimulate new growth. It is necessary to prune away any branches that are damaged, diseased, or dead. In addition, the height of the tree should be reduced to a certain level, and the general form of the tree should be preserved once it has been trimmed. In addition, removing any aging, diseased, and non-productive branches is essential to stimulate the growth of a greater quantity of guava fruits.

T3 - Cutting with 8000ppm IBA in Field Soil:

It is possible to grow new guava plants from cuttings using a technique known as Guava Cutting with 8000ppm IBA in Field Soil. First, healthy cuttings of guava plants are selected and then immersed for 10–15 seconds in a Rooting hormone solution that contains 8000 ppm of Indole-3-butyric acid (IBA). This helps the cuttings to take root. The hormone has a dual purpose: it hastens the process of cutting the growing root and also improves its prospects of surviving. In order to successfully stimulate root development, the IBA must be combined with the soil at a concentration of 8,000 parts per million (ppm). After that, the cuttings are planted in the damp soil of the field, taking care that the end that was cut is in touch with the ground. To ensure that there is sufficient humidity, the soil should be maintained wet, and the cuttings should be covered with a plastic bag at all times. The Rooting process should take between one and two months and result in guava plants that are healthy and well-established.

Cutting from the parent plant of a guava plant with 8000 ppm IBA in the field soil is the first stage in the cutting process. The length of the cutting should be between three and four inches, and it should not include any blooms or fruits. In addition to this, it should be harvested from a robust and healthy region of the plant. After the cutting has been taken, the cut end should be immersed in the IBA solution and then planted in the ground immediately thereafter. Before planting, you should ensure that the soil has good drainage and is loose. You should also mix the IBA solution into the soil. After the planting of the cutting, the soil should be watered and maintained at a damp but not soaked state.

T4 - Cutting with 8000ppm IBA in Orchard Soil:

Guava cuttings that have been fertilized with 8000 ppm of IBA and planted in orchard soil are one method of reproducing guava plants. In order to carry out the Process, a cutting is taken from an established guava tree and then rooted in orchard soil that contains 8000 ppm of the chemical IBA. Because of its high success rate and simple application, this strategy is often used in propagating guava plants from cuttings.

The procedure begins with the removal of a cutting from an established guava tree, which is the second phase. In general, the cutting length should be between six to eight inches, and it should have many nodes that will develop roots when plan ted. The cutting should be taken from a tree that is in good condition and is free of any diseases or pests before it can be used. After the cutting has been taken, it has to be kept in a sterile container containing water to maintain its hydration level until it is time to root it.

After that, the orchard soil containing 8000ppm IBA should be prepared. This soil should not be compacted, should have good drainage, and should have a pH that ranges from 5.5 to 6.5. The IBA must be uniformly dispersed throughout the soil in order to guarantee that all parts of the cutting get enough exposure to the Rooting hormone. After the soil is prepared, it is time to plant the guava.

T5 – Cutting in Orchard Soil and Sand (2:1):

Cutting guavas in the soil and sand of an orchard is a popular technique utilized in commercial fruit production. Taking a cutting from an established guava tree and planting it in a container containing orchard soil and sand is the first step in this process. The ratio of soil to sand is typically two parts soil to 1 part sand; however, this ratio might change based on the soil and sand being utilized.

In order to prepare the soil and sand mixture, the two components are combined in the appropriate proportions and then stirred together. As soon as the mixture is finished being prepared, the cutting is put into the container and buried until it reaches the top of the stem. This ensures that the cutting will have adequate root development and will be able to receive sufficient nutrition to sustain itself. The cutting should be maintained moist at all times, and the container ought to be put in a warm, sunny spot.

When the cutting has established new roots and started to develop new shoots, it is then possible to transplant it into the orchard or any other site of your choosing. The ratio of soil and sand in the mixture must be kept the same as it was during the cutting stage. It is important to water the soil and sand mixture consistently, especially during the warm summer months, to keep it moist and to guarantee that the guava tree has sufficient nutrients for its continued growth. There is the potential for the soil in the orchard to absorb fertilizers.

T6 – Cutting in Orchard Soil and Sand and FYM (2:1:1):

The propagation of guava plants by the use of guava cuttings is a widespread practice. This technique is favoured over other methods of propagation, such as air layering, due to the fact that it is simple to implement and has a high per cent (%)age of success. Guava cuttings are an extremely dependable approach that may be utilized to produce a huge number of new plants quickly and at a reduced expense.

Orchard soil, sand, and FYM (farmyard manure) combined in a ratio of 2:1:1 are the three components that should be used to create the optimal soil mix for the vegetative propagation of guava plants via cuttings. The soil in the orchard has to be of high quality and ought to have an unbiased pH. In addition to that, it shouldn't have any weeds or other unwanted impurities. The sand should have a granular consistency and a coarser grain size. The FYM should be of high quality and should not include any weed seeds or other potentially harmful impurities of any kind.

Before planting guava cuttings, the soil mix for the cuttings should have all of its components thoroughly mixed together and included before planting. This helps prevent any vitamin deficits and ensures that the mixture has a consistent consistency throughout. Following the completion of the preparation of the soil mixture, the guava cuttings can then be planted into it.

T7 – Cutting in Orchard Soil and Sand and VAM (2:1:1):

The method of propagation known as Guava Cutting in Orchard Soil and Sand and VAM (2:1:1) is one that is utilized for growing guavas in orchards. The proportions of two parts of orchard soil, one-part sand and one part VAM ensure that the cuttings receive the adequate amount of water, nutrients, and air circulation necessary for them to flourish. The process begins with removing a cutting from a young guava plant, followed by the planting of the cutting in a medium consisting of a mixture of two parts orchard soil, one part sand, and one part VAM. Before putting the soil in the pot or container that will be used to grow the plant, it must first be prepared by combining all three components of the soil in a separate container.

While the VAM contributes to improving the soil's structure and drainage, the sand helps minimize soil compaction and loosens the soil so that it may be worked more easily. After that, the cutting is planted in the soil and given consistent watering in order to stimulate the growth of roots and establish the plant. The soil from the orchard is then utilized to supply the nutrients and minerals the plant requires to be healthy and flourish.

The practice of cutting guavas in orchard soil mixed with sand and VAM in a ratio of 2:1:1 is a well-liked option among orchardists since it creates a favourable environment in which the young guava plants can flourish. Guavas, which may be grown into a crop of delicious fruit using this simple and inexpensive method of propagation, can be grown easily and quickly.

T8 – Cutting in Orchard Soil and Sand and VC (2:1:1):

To propagate guava plants, a technique known as Guava Cutting in Orchard Soil with Sand and VC (2:1:1) is utilized. The number of guava plants that can be grown from a single plant using this technique can be increased. The use of this method removes the need for farmers to acquire fresh plants from nurseries, which is one of the many advantages of using this method.

A procedure that requires cutting a strong stem off a guava plant using a sharp knife or blade is described here. The stem should be at least two inches long, and there should be at least two or three nodes on it. After that, the stem needs to be chopped into portions that are around 2 inches long. At a minimum, one node and one or two leaves ought to be present in every region.

The following step is to plant these portions using a combination of orchard soil, sand, and VC. Before planting, the soil should be soaked, and afterwards, it should be kept moist without becoming saturated. It is recommended that the portions be planted between one and four inches deep into the soil and that they be maintained in a warm and moist climate. The guava cuttings should be monitored for about a month until the roots are established, and the plants start to grow. Once the plants are established,

T9 – Cutting in Orchard Soil and Sand and Peat (2:1:1):

Guava cutting in orchard soil mixed with sand and peat in a ratio of 2:1:1 is a straightforward method for the propagation of guava trees from already-established plants. In this approach, a cutting is taken from a branch of an established guava tree, dipped in a Rooting hormone, and then planted in a mixture consisting of two parts orchard soil, one part sand, and one part peat. The cutting is subsequently rooted.

The goal of the peat and sand is to help supply moisture and aeration to the roots of the cutting, which will assist it in taking root and growing into a new guava tree. This can be accomplished by providing the cutting with these two things. As the cutting takes root and begins to grow new foliage, the orchard soil is used to give the cutting with nutrients and support as it goes through this process.

After the cutting has been planted, it has to be watered on a regular basis to maintain the moisture level in the soil and prevent the cutting from becoming dry. To further assist the soil in retaining moisture, a very light covering of mulch should always be maintained over it. The cutting needs to be kept in a location that receives partial shade, and it needs to be monitored to ensure that it is taking root and growing correctly. If you want the cutting to continue growing, you should replant it in the ground or a larger container once it has established roots and developed a new leaf. This will allow the plant to thrive.

T10 – Cutting in Orchard Soil and Sand and Perlite (2:1:1):

The cutting of guava trees in orchard soil mixed with sand and perlite at a ratio of 2:1:1 is a common and successful approach for the propagation of guava trees. When carrying out this method of propagation, a cutting is taken from an established guava tree and then replanted in a medium that consists of equal parts of orchard soil, sand, and perlite. It is recommended that the ratio of soil to sand to perlite be 2:1:1, which means that there should be two parts of soil, one part of sand and one component of perlite.

The cutting taken from the guava tree is given the best chance of taking root and producing fruit that is healthy and delectable when it is propagated using this method of propagation. The soil from the orchard supplies the tree cutting with the necessary nutrients, and the addition of sand and perlite helps to aerate the ground and makes sure that the roots have plenty of opportunity to expand. Because of the perlite, the soil is able to maintain its lightness, which is especially beneficial in locations with greater levels of humidity. Additionally, the sand helps keep the soil from being compacted and acts as a barrier against waterlogging.

When planting guava cuttings, it is essential to ensure that the cuttings were taken from a disease-free and healthy tree. The cutting ought to be at least 12 centimetres (at least 6 inches) in length and ought to be attached to three or four leaves. After the cutting has been taken, it needs to be planted as soon as possible.

T11 – Cutting in Orchard Soil and Sand and Vermiculite (2:1:1):

Cuttings of guava trees planted in a mixture of orchard soil, sand, and vermiculite can be used to successfully propagate new guava trees. The soil, sand, and vermiculite are combined in a ratio of 2:1:1, which results in an environment that is ideal for Rooting guava cuttings since it is aerated and has a lot of nutrients. The nutrients and minerals that the cuttings require for growth are supplied by the soil in which they are planted. The sand acts as a drainage system, removing excess water and allowing air and other particles to circulate freely throughout the soil. Because vermiculite is so effective at retaining moisture, cuttings can be kept adequately hydrated throughout the root process.

When you are preparing the soil mixture, it is essential to check that it is dispersed uniformly and does not include any huge clumps. After the mixture has been prepared, the cuttings can be inserted into the mixture and then covered with extra soil to create an environment that is conducive to roots.

It is essential to pay special attention to the different degrees of moisture that are present in the soil mix. The cuttings are at risk of rotting before they take root if the soil is too damp. It is possible that the cuttings will not root if the soil is too dry. The cuttings should start to root within a few weeks if the mixture is kept slightly wet at all times.

T12 – Cutting in Orchard Soil and Sand and Saw Dust (2:1:1):

Both commercial and amateur guava growers utilise the process of propagating a guava tree by cutting roots and burying them in a mixture of orchard soil, sand, and sawdust. To do this, a cutting must be taken from an established guava tree, dipped in a Rooting hormone, and then planted in a medium consisting of orchard soil, sand, and sawdust. Orchard soil, sand, and sawdust are commonly combined in the following proportions: 2 parts orchard soil, 1 part sand, and 1 part sawdust.

The soil in the orchard supplies the cutting with the essential nutrients and minerals it needs to develop into a full plant. Sawdust is added to the cutting process because it helps to keep some of moisture in the air and gives additional nutrients. The use of sand helps to increase the drainage and aeration of the medium, which in turn reduces the likelihood that the cutting may develop root rot.

When you are planting the cutting, it is essential to have a depth in the medium of approximately 4-5 inches at all times. The cutting needs to be planted at an angle so that there is adequate drainage of the medium and that there is less of a chance that the cutting will develop root rot due to the soil being overly wet. The cutting needs to be watered on a consistent basis, but it should not be soaked. After the cutting has been established in its new home, it should be maintained in a spot that receives dappled sunshine and is shielded from harsh winds. Additionally, the location needs to be warm.

3.2. Exp2: Role of soil pH on rooting behaviour of guava stem cutting

Table 2 Role of media pH on rooting behaviour of guava stem cutting

Treatment symbol	Treatment details
T1	pH 4.5
T2	pH 5.0
T3	pH 5.5
T4	pH 6.0
T5	pH 6.5
T6	pH7.0
T7	pH 7.5
T8	Cutting in Normal field soil with 8000ppm IBA

*Guava Orchard soil +Sand + VC (2:1:1)

T1 – pH 4.5:

Soil pH plays an essential role in the rooting behaviour of guava stem cuttings. Generally, guava stems cuttings root better in slightly acidic soils with a pH range of 4.5 to 6.5. However, some studies have shown that guava cuttings can root well in slightly alkaline soils with pH levels up to 8.0. Soil pH levels of 4.5 provide the ideal environment for guava cuttings to root. A soil pH of 4.5 is considered to be slightly acidic, which is optimum for guava stem cuttings to absorb essential nutrients. Furthermore, soils with pH levels of 4.5 contain a good amount of organic matter, which provides an ideal environment for the guava cuttings to develop roots.

Additionally, the soil pH of 4.5 reduces the risk of nutrient deficiencies, as the acidic soil helps to release essential nutrients, making them more accessible to guava cuttings. This helps to ensure that the cuttings have access to essential nutrients, which is important for root development. Furthermore, the soil pH of 4.5 helps to prevent diseases and pests, as the environment is not suitable for them to thrive.

T2 – pH 5.0:

Soil pH 5.0 is ideal for the rooting behaviour of guava stem cuttings. At this soil pH, the availability of essential nutrients to the plant is optimal, allowing the stem cutting to establish roots efficiently. Additionally, the soil pH of 5.0 provides a slightly acidic environment which helps to prevent disease and fungal growth. The acidic soil environment also helps to create an ideal environment for the stem cutting to absorb water and nutrients, promoting healthy growth and Rooting. Guava stems cuttings placed in soil pH 5.0 are likely to root faster and establish healthy root systems than those placed in the soil with a different pH level.

T3 – pH 5.5:

A soil pH of 5.5 is ideal for rooting guava stem cuttings. The low pH helps ensure that sufficient amounts of essential nutrients, such as nitrogen, phosphorus, and potassium, are available to the stem cuttings to promote healthy root growth. The low pH also helps to protect the stem cutting from potential pathogens and helps to reduce the shock of transplanting. Furthermore, the low pH helps to reduce the amount of moisture that can be held in the soil, which can help to reduce the risk of over-watering and the associated problems. Ultimately, the low pH helps to promote the Rooting of guava stem cuttings, making it an ideal pH for rooting this species.

T4 – pH 6.0:

Cuttings from guava stem usually do best when planted in soil with a pH of 6.0. When the soil pH is just right, it can supply the nutrients and minerals that guava cuttings need to take hold and grow new guava plants. The cutting is less likely to decay from a fungal or bacterial infection when the soil pH is about 6.0. Soil with a pH of 6.0 provides an optimal environment for the cutting to absorb water, oxygen, and other nutrients and to grow a healthy root system. To sum up, a soil pH of 6.0 is crucial for properly germinating guava stem cuttings.

T5 – pH 6.5:

Soil pH 6.5 is an ideal soil condition for the Rooting behaviour of guava stem cuttings. A soil pH of 6.5 ensures that the soil has the correct levels of nutrients and minerals for the guava stem cuttings to root quickly and successfully. Soil with a pH of 6.5 also contains enough moisture to keep the soil from drying out and to allow the guava stem cuttings to take in water. Additionally, the pH 6.5 soil does not contain too much salt, which can inhibit root growth of the guava stem cuttings. As a result, guava stem cuttings will root faster and more efficiently in soil with a pH of 6.5.

T6 – pH 7.0:

Soil pH 7.0 is a neutral pH level and is considered ideal for guava stem cuttings. At this level, the soil has the right balance of nutrients and acidity to promote strong Rooting and optimal growth of the guava cutting. The soil pH affects the availability of nutrients for the cutting, and a neutral pH is important for the uptake of nutrients such as nitrogen, phosphorus, and potassium. At a soil pH of 7.0, guava stem cuttings will also be able to absorb water and minerals from the soil more effectively, which is important for their growth and development. Additionally, the neutral pH level of the soil helps reduce the risk of diseases by preventing the growth of fungi and other pathogens.

T7 – pH 7.5:

The soil pH of 7.5 is considered to be a neutral pH, which is ideal for the rooting behaviour of guava stem cutting. This pH level provides an ideal balance between acidity and alkalinity, which ensures that the guava plants are able to absorb the necessary nutrients from the soil. The neutral pH also prevents the soil from becoming overly acidic, which can inhibit the growth of the guava plants. The neutral pH level also helps the guava plants absorb the necessary water, which is essential for the Rooting behaviour of guava stem cutting.

T8 – Cutting in Normal Field Soil with 8000ppm IBA:

Cutting in average field soil with 8000 ppm of IBA is a technique in which a cutting solution is applied to the soil to encourage the Rooting of plants, particularly in places where the soil has a poor nutrient content. This is done in order to improve plant growth in locations where the soil is deficient in nutrients. Plants can benefit from the hormone indole-3-butyric acid (IBA), which is found in the cutting solution. IBA is a plant hormone that occurs naturally and is frequently employed in the process of plant propagation, particularly in regions where the soil has a poor nutrient content and is not favourable to rooted. IBA promotes the division of plant cells and the development of new roots. In these types of environments, the usage of IBA is very common.

When cutting, it is used in regular field soil containing 8000 ppm of IBA; the cutting solution is applied directly to the soil to guarantee that it is evenly distributed and to ensure that the plant can absorb the hormone. The quantity of IBA added to the solution is determined, in part, by the variety of plants being multiplied and the level of Rooting that is required. In general, the effectiveness of the cutting solution for Rooting increases in proportion to the amount of IBA that is present in it. When the cutting solution is applied to the soil, it is critical to make certain that the soil is thoroughly saturated with water. This will guarantee that the cutting solution is dispersed uniformly across the soil and that the hormone is able to create a bond with the soil successfully.

3.3 Factors

3.3.1. Growing conditions of the guava cutting

The guava cutting was planted in a position that received much sunlight, in soil that was easy to drain and had a lot of organic matter already in it. The cutting was given consistent watering, then treated with a mixture of several types of fertiliser to promote healthy development. In addition, the cutting was shielded from harsh winds and temperatures to guarantee that the growth would be healthy and successful.

A. Open Field Condition

When harvesting guavas in Open field environments, one must had access to a large Opened area in which the guava trees were placed. In most cases, the space was cleaned up and maintained to prevent the growth of weeds and insects. we ensured that the seedlings got all of the necessary nutrients the soil was tilled and treated before planting. After the plants had been pruned and trimmed to the size that was desired, the guava fruits were collected for eating. After this stepped, the fruits were made ready for the next stage of processing, which includes sorting, grading, and packing. The majority of the time, this procedure was carried out manually, using specialised equipment such as guava cutter, a knife, and a basket.

B. Under Protected Condition

Guava cuttings were grown from seed in a variety of environments, including greenhouses, containers, and even directly in the ground. The soil needed to had good drainage and a high concentration of nutrients. Guava cuttings should have been irrigated consistently so that the soil remains wet but not soaked. The ideal conditions for optimum development include either complete or partial exposure to the sun, and temperatures should range from 65 to 85 degrees Celsius (18 to 29 degrees Celsius).

In ordered to promote healthy development, guava cuttings should have been treated once a month used a fertiliser that had a balanced nutrient profile

3.3.2 Seasons of root induction.

There will be one seasons for each experiment

Season 1: March-April- 2021 and 2022

Methods to adjust the pH

pH obtained through the following tables as per treatments:

Kilogram of Aluminium Sulphate per 100 kg media to lower the pH to the Recommended Level

Table 3 Kilogram of Aluminium Sulphate per 10 square feet to Lower the pH

Present pH	**Desired pH**				
	6.5	**6.0**	**5.5**	**5.0**	**4.5**
8.0	1.8	2.4	3.3	4.2	4.8
7.5	1.2	2.1	2.7	3.6	4.2
7.0	0.6	1.2	2.1	3.0	3.6
6.5		0.6	1.5	2.4	2.7
6.0			0.6	1.5	2.1

Present pH	Desired pH				
	6.5	**6.0**	**5.5**	**5.0**	**4.5**
8.0	0.3	0.4	0.5	0.6	0.7
7.5	0.2	0.3	0.4	0.5	0.6
7.0	0.1	0.2	0.3	0.4	0.5
6.5		0.1	0.2	0.3	0.4
6.0			0.1	0.2	0.3

3.4. OBSERVATIONS TO BE RECORDED:

Observation to be recorded at different time intervals after transplanting, i.e. -

30 Days

60 Days

90 Days

The following observations were recorded

1. Per cent Callused
2. Per cent Rooted
3. Number of root per cutting
4. Root length (cm)
5. Number of shoots
6. Maximum Shoot length (cm)
7. Number of leaves

8. Length of the leaf (cm)
9. Leaf area (cm$^{2)}$
10. Per cent (%)age survival of cutting (%)
11. Mortility (%)
12. Time taken to Rooting,
13. Time taken for first bud sprouts

1. Per cent Callused

The per cent callused on the rooting of guava is the measure of how much of the fruit is callused or hardened due to the natural process of ripening. The higher the per cent (%)age of callused guava, the more mature the fruit is and the better it will taste. Guava can become callused even when it is still green, so it is important to check the per cent callused before harvesting.

2. Per cent Rooted

The per cent Rooted in the rooting of guava is a metric used to measure the robustness of a network. It is defined as the ratio of the number of nodes that can reach all other nodes in the network to the total number of nodes in the network. This metric is particularly important for large networks, as it can indicate how well the nodes in the network are connected. A high per cent Rooted network will result in better communication and faster data transmission.

3. Number of Roots Per Cutting

The number of roots per cutting on the rooting of guava can vary depending on the size and health of the parent plant. Generally, a cutting should contain at least two roots; the healthiest cuttings can have up to four or five. The more roots a cutting has, the more likely it is to survive in its new environment and produce a healthy plant. Additionally, the larger the parent plant, the more roots a cutting will likely have. It is important to take cuttings from healthy and disease-free plants in order to ensure successful propagation.

4. Root Length (cm)

Root Length (cm) is a measure of the total length of the root system of a guava plant. It is an important indicator of the overall health of the plant and its ability to absorb nutrients and water from the soil. The longer the root length, the better the plant will be able to access nutrients and water from the surrounding soil. Longer root length also indicates that the plant is more likely to survive in harsher environmental conditions. Root length is typically measured by carefully excavating the soil around the plant and measuring the total length of the root system.

5. **Number of Shoots**

Guava trees are fast-growing and can produce up to 20 shoots per season. The shoots will generally appear in the early spring and then again in the late summer. When the tree is mature, it can produce up to 30 shoots per season. The shoots will emerge from the ground and then quickly form into shoots that can reach up to 3 feet in length. The shoots will then form into branches and eventually bear fruit. Proper care and pruning are necessary to ensure a healthy guava tree that will produce an abundance of fruit.

6. **Maximum Shoot Length (cm)**

The maximum shoot length (cm) on the rooting of guava is approximately 40-45 cm. This length is the maximum length of shoot growth that can be sustained and is usually determined by taking the length of the longest shoot on the plant. The maximum shoot length may also vary depending on the variety of guava, as some varieties may reach longer lengths than others. Generally, guava shoots grow rapidly and may reach their maximum length within a few weeks.

7. **Number of Leaves**

The number of leaves on the rooting of guava can vary depending on the variety. Generally, guava trees produce leaves with serrated edges that are 2 to 6 inches long and 1 to 4 inches wide. The leaves are usually bright green and glossy on top, with a lighter green colour on their underside. Guava trees can produce up to 250 leaves in a season, although the average is closer to 100.

8. **Length of Leaf (cm)**

The length of the leaf on the guava tree can range from 2 to 12 cm, with the average being 6 cm. The shape of the leaf is ovate to elliptic and the margins are serrated. The leaves are dark green with a glossy surface, and the underside is pale green. Guava trees are evergreen and the leaves remain on the tree throughout the year.

9. Leaf Area (cm^2)

The Leaf Area on the rooting of guava is an essential factor for the overall health and growth of the plant. It is where photosynthesis occurs and the leaves absorb the necessary nutrients to produce sugar and oxygen. By providing a high leaf area, guava plants are able to grow large and healthy and produce more fruits. The leaf area also helps regulate the plant's temperature and protect it from the elements. The leaves also act as a barrier against pests and diseases.

10. Per cent (%)age Survival of Cutting (%)

The Per cent (%)age Survival of Cutting on the rooting of guava is highly dependent on the variety of guava used, the weather conditions, and the soil type. Generally, the survival rate is around 70-90%. The cuttings should be taken from healthy, disease-free plants and planted in well-drained, fertile soil. The cuttings should also be protected from direct sunlight and should be watered regularly. Adequate drainage is also important to ensure the survival of the cuttings. Additionally, the survival rate can be increased by using Rooting hormones and providing the cuttings with adequate amounts of nutrients.

11. Time Taken to Rooting

Rooting a guava tree can take anywhere from three to six months, depending on the tree's health and the environment it is planted in. During this time, the roots need to be kept moist and the tree should receive adequate sunlight. Once the root system has been established, the tree should be pruned to keep it healthy and to promote further growth. With proper care, the guava tree can produce fruit within one to two years after it has been planted.

12. Time Taken for first bud Sprouts

The time taken for the first bud sprouts on the rooting of guava depends on environmental conditions such as temperature and humidity. Generally, guava plants can take anywhere from 6-8 weeks to sprout buds from seed. Guava trees planted from seedlings will usually start to sprout within 4-6 weeks. The time taken for the first bud sprouts may be shorter in warm and humid climates.

3.5. Tukey Test for analysis:

The Tukey test in SPSS is a posthoc analysis technique that is used to identify significant differences between individual means in an ANOVA analysis. This test is known as the

Tukey-Kramer test or simply the Tukey test. The Tukey test is used to compare all possible pairs of means in a single-factor ANOVA and determine which, if any, of those means are significantly different from each other. The test is based on the concept of Student Zed Range (q), which measures the difference between means divided by the standard error of the difference. The Tukey test is considered to be one of the most powerful posthoc tests and is often used in the analysis of experimental data. This test is used whenever it is necessary to establish whether or not the interaction between three or more factors is statistically significant. Unfortunately, the results of this test are not simply a sum or product of the individual levels of significance.

3.6. Parameter Analysis:

Parameter analysis is an important part of guava propagation. It is the process of understanding the impact of different parameters on the growth and development of plants. Parameter analysis helps identify the best conditions for guava propagation, such as soil type, temperature range, nutrient availability, and other environmental conditions. By understanding these parameters, growers can ensure their guava plants are given the best conditions for successful growth and production.

3.7. Weather Data: 2021 Month wise

Month	**Avg. Temperature (°C)**	**Total Rainfall (mm)**	**Avg. Humidity (%)**
January	12.3	50	68
February	14.5	45	64
March	18.2	30	55
April	22.5	20	50
May	26.7	35	48
June	28.9	200	70
July	27.5	600	85
August	26.8	650	87
September	25.4	300	80

October	22.3	100	75
November	18.0	40	70
December	14.5	30	68

3.8 Weather Data: 2022 Month wise

Month	Avg. Temperature (°C)	Total Rainfall (mm)	Avg. Humidity (%)
January	12.5	55	69
February	14.7	50	65
March	18.5	35	56
April	22.8	25	52
May	27.0	40	49
June	29.1	210	72
July	27.8	620	86
August	27.0	670	88
September	25.6	320	81
October	22.5	110	76
November	18.2	45	71
December	14.7	35	69

Sourse: IIS&WC Dehradun, 2021 and 2022

Results & Discussion

4. Results & Discussion

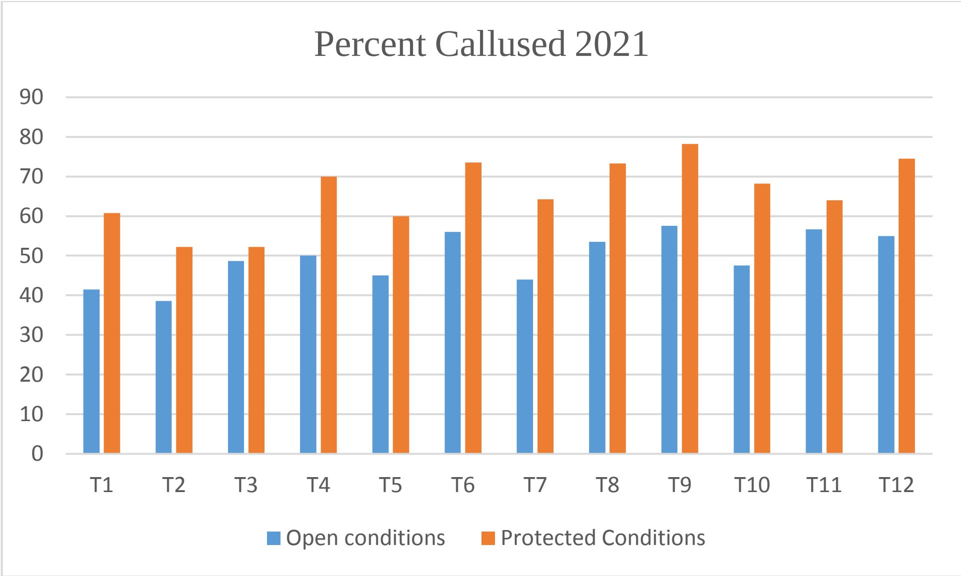
The results of the current study, titled "Studies of rooting media and their pH on the rooting behaviour of stem cutting of Guava (*Psidium guajava* L*)* under Himalayan foot hillconditions" are presented. The findings on the influence of IBA on the features were recorded and statistically analysed. The observed data have been analysed in tables and shown in figures.

In the table below, we find the critical difference between the treatment T1-T12 in Open Conditions 2021 and Protected Conditions 2021 at 30 DAP, 60 DAP and 90 DAP and also Open Conditions 2022 and Protected Conditions 2022 at 30 DAP, 60 DAP, and 90 DAP.

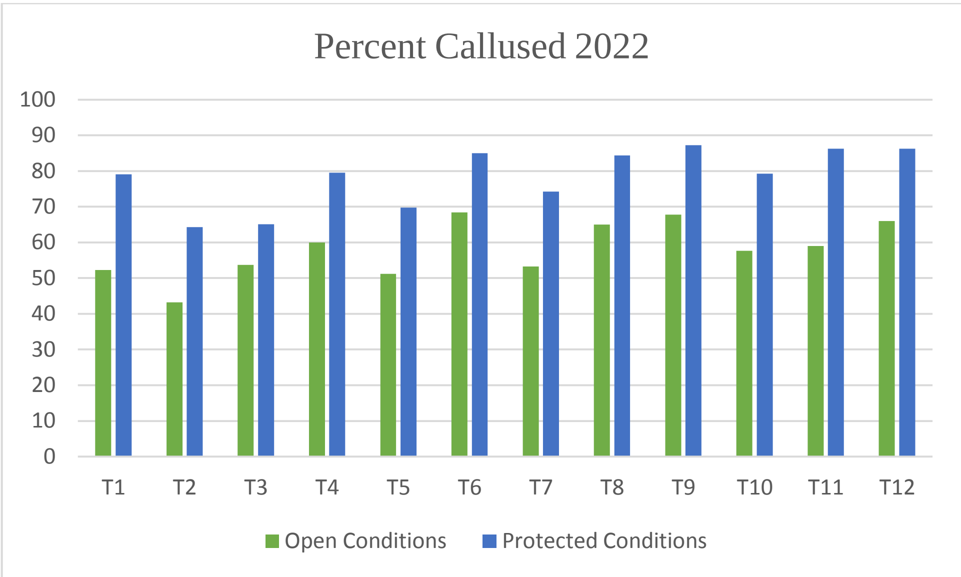
8.1: Impact of different growing media on per cent (%) Callused in Guava cuttings (*Psidium guajava* L.):

Treatment Symbol	2021		2022	
	Per cent (%) Callused		Per cent (%) Callused	
	Open Conditions	Protected Conditions	Open Conditions	Protected Conditions
T1	41.48	60.75	52.30	79.12
T2	38.56	52.22	43.25	64.28
T3	48.65	52.22	53.68	65.12
T4	50.01	69.98	60.00	79.57
T5	45.00	60.00	51.25	69.75
T6	56.05	73.55	68.45	85.05
T7	43.95	64.25	53.25	74.28
T8	53.52	73.25	64.99	84.39
T9	57.55	78.22	67.75	87.24
T10	47.54	68.21	57.65	79.25
T11	56.64	64.03	58.98	86.24
T12	54.94	74.53	65.97	86.27
CD at 5%	3.80	5.20	5.04	4.59

Table 1 Per cent (%) Callused



Graph 1 Per cent (%) Callused 2021



Graph 2 Per cent (%) Callused 2022

Groups		T1			T2			T3			T4			T5			T6		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-9.70	0.078	NS	-6.51	0.239	NS	-5.46	0.394	NS	-8.63	0.051	NS	-7.30	0.134	NS	-11.52	0.316	NS
	G3	-20.21	0.001	S	-15.57	0.005	S	-6.55	0.260	NS	-19.83	0.000	S	-16.05	0.003	S	-22.17	0.030	S
	G4	-31.98	0.000	S	-25.35	0.000	S	-15.49	0.006	S	-28.67	0.000	S	-25.11	0.000	S	-32.18	0.004	S
G2	**G1**	9.70	0.078	NS	6.51	0.239	NS	5.46	0.394	NS	8.63	0.051	NS	7.30	0.134	NS	11.52	0.316	NS
	G3	-10.50	0.056	NS	-9.06	0.078	NS	-1.09	0.986	NS	-11.20	0.014	S	-8.75	0.067	NS	-10.65	0.375	NS
	G4	-22.28	0.001	S	-18.84	0.001	S	-10.03	0.059	NS	-20.03	0.000	S	-17.80	0.001	S	-20.66	0.042	S
G3	**G1**	20.21	0.001	S	15.57	0.005	S	6.55	0.260	NS	19.83	0.000	S	16.05	0.003	S	22.17	0.030	S
	G2	10.50	0.056	NS	9.06	0.078	NS	1.09	0.986	NS	11.20	0.014	S	8.75	0.067	NS	10.65	0.375	NS
	G4	-11.77	0.033	S	-9.78	0.056	NS	-8.94	0.095	NS	-8.83	0.046	S	-9.05	0.058	NS	-10.01	0.423	NS
G4	**G1**	31.98	0.000	S	25.35	0.000	S	15.49	0.006	S	28.67	0.000	S	25.11	0.000	S	32.18	0.004	S
	G2	22.28	0.001	S	18.84	0.001	S	10.03	0.059	NS	20.03	0.000	S	17.80	0.001	S	20.66	0.042	S
	G3	11.77	0.033	S	9.78	0.056	NS	8.94	0.095	NS	8.83	0.046	S	9.05	0.058	NS	10.01	0.423	NS

Table 2 Tukey's test for Per cent (%) Callused T1-T6

For treatment 1 there is a significant difference between the groups G1(Open 2021) - G3(Open 2022), G1(Open 2021) – G4(Protected 2022), G3(Open 2022)-G1(Open 2021) and G4(Protected 2022)-G1(Open 2021) with a significance value of 0.49,0.006,0.49,0.006 and mean difference of -23.62, -35.47, 23.62, 35.47. On the other hand, the remaining groups doesn’t have mean significant difference.

For treatment 2 there is a significant difference between the groups G1 (Open 2021) – G4 (Protected 2022) and G4(Protected 2022)-G1(Open 2021) with a significance value of 0.016 and mean difference of -28.17 and 28.17. On the other hand, the remaining groups doesn’t have mean significant difference.

For treatment 3 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022) and G4(Protected 2022)-G1(Open 2021) with a significance value of 0.005 and mean difference of -31.74 and 31.74. On the other hand, the remaining groups doesn’t have mean significant difference.

For treatment 4 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022) and G4(Protected 2022)-G1(Open 2021) with a significance value of 0.045 and mean difference of -33.30, 33.30. On the other hand, the remaining groups doesn’t have mean significant difference.

For treatment 5 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022), G4(Protected 2022)-G1(Open 2021), G2(Protected 2021) – G4(Protected 2022) and G4(Protected 2022) – G2(Protected 2021) with significance value of 0.005, 0.036 and mean difference of -36.30, 36.30 and -25.19, 25.19. and the remaining groups doesn’t have mean significant difference.

For treatment 6 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022) and G4(Protected 2022)-G1(Open 2021) with a significance value of 0.049 and mean difference of -24.86, 24.86. On the other hand, the remaining groups doesn’t have mean significant difference.

Groups		T7			T8			T9			T10			T11			T12		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-12.36	0.473	NS	-10.10	0.636	NS	-11.17	0.454	NS	-11.17	0.378	NS	-6.67	0.784	NS	-10.68	0.554	NS
	G3	-21.23	0.117	NS	-16.26	0.280	NS	-22.09	0.061	NS	-21.71	0.042	S	-15.50	0.206	NS	-16.88	0.216	NS
	G4	-30.82	0.023	S	-27.67	0.042	S	-33.38	0.007	S	-30.35	0.007	S	-28.01	0.018	S	-30.01	0.021	S
G2	**G1**	12.36	0.473	NS	10.10	0.636	NS	11.17	0.454	NS	11.17	0.378	NS	6.67	0.784	NS	10.68	0.554	NS
	G3	-8.87	0.707	NS	-6.16	0.878	NS	-10.92	0.472	NS	-10.53	0.424	NS	-8.83	0.618	NS	-6.20	0.857	NS
	G4	-18.46	0.187	NS	-17.57	0.228	NS	-22.21	0.059	NS	-19.18	0.073	NS	-21.33	0.066	NS	-19.33	0.142	NS
G3	**G1**	21.23	0.117	NS	16.26	0.280	NS	22.09	0.061	NS	21.71	0.042	S	15.50	0.206	NS	16.88	0.216	NS
	G2	8.87	0.707	NS	6.16	0.878	NS	10.92	0.472	NS	10.53	0.424	NS	8.83	0.618	NS	6.20	0.857	NS
	G4	-9.58	0.658	NS	-11.41	0.548	NS	-11.29	0.446	NS	-8.64	0.575	NS	-12.50	0.355	NS	-13.12	0.396	NS
G4	**G1**	30.82	0.023	S	27.67	0.042	S	33.38	0.007	S	30.35	0.007	S	28.01	0.018	S	30.01	0.021	S
	G2	18.46	0.187	NS	17.57	0.228	NS	22.21	0.059	NS	19.18	0.073	NS	21.33	0.066	NS	19.33	0.142	NS
	G3	9.58	0.658	NS	11.41	0.548	NS	11.29	0.446	NS	8.64	0.575	NS	12.50	0.355	NS	13.12	0.396	NS

Table 3 Tukey's test for Per cent (%) Callused T7-T12

For treatment 7 there is a significant difference between the groups G1(Open 2021) - G3(Open 2022), G1(Open 2021) – G4(Protected 2022), G3(Open 2022)-G1(Open 2021) and G4(Protected 2022)-G1(Open 2021) with significance value of 0.49,0.006,0.49,0.006 and mean difference of -23.62, -35.47, 23.62, 35.47. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 8 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022) and G4(Protected 2022)-G1(Open 2021) with a significance value of 0.016 and mean difference of -28.17 and 28.17. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 9 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022) and G4(Protected 2022)-G1(Open 2021) with a significance value of 0.005 and mean difference of -31.74 and 31.74. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 10 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022) and G4(Protected 2022)-G1(Open 2021) with a significance value of 0.045 and mean difference of -33.30, 33.30. On the other hand, the remaining groups doesn't have mean significant difference.

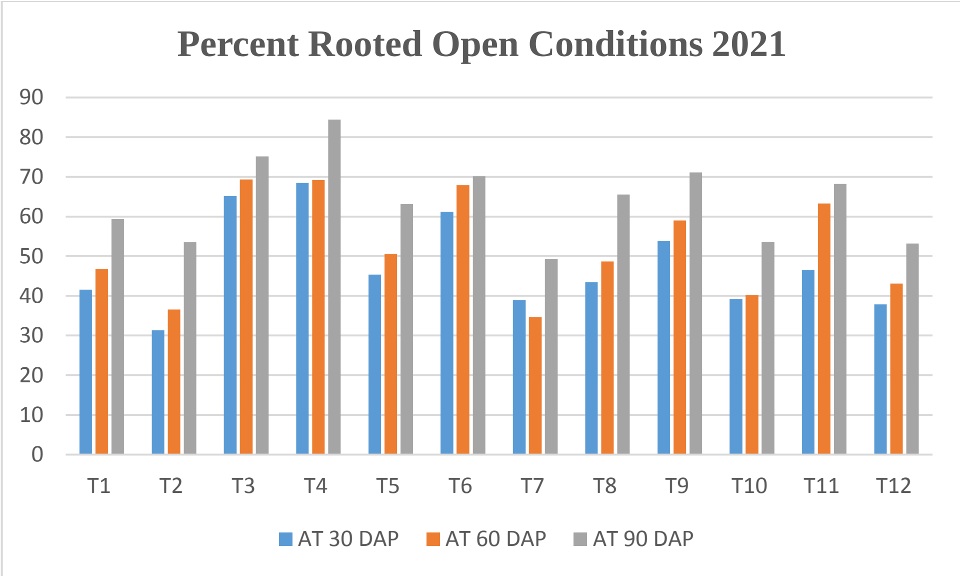
For treatment 11 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022), G4(Protected 2022)-G1(Open 2021), G2(Protected 2021) – G4(Protected 2022) and G4(Protected 2022) – G2(Protected 2021) with significance value of 0.005, 0.036 and mean difference of -36.30, 36.30 and -25.19, 25.19. and the remaining groups doesn't have mean significant difference.

For treatment 12 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022) and G4(Protected 2022)-G1(Open 2021) with a significance value of 0.049 and mean difference of -24.86, 24.86. On the other hand, the remaining groups doesn't have mean significant difference.

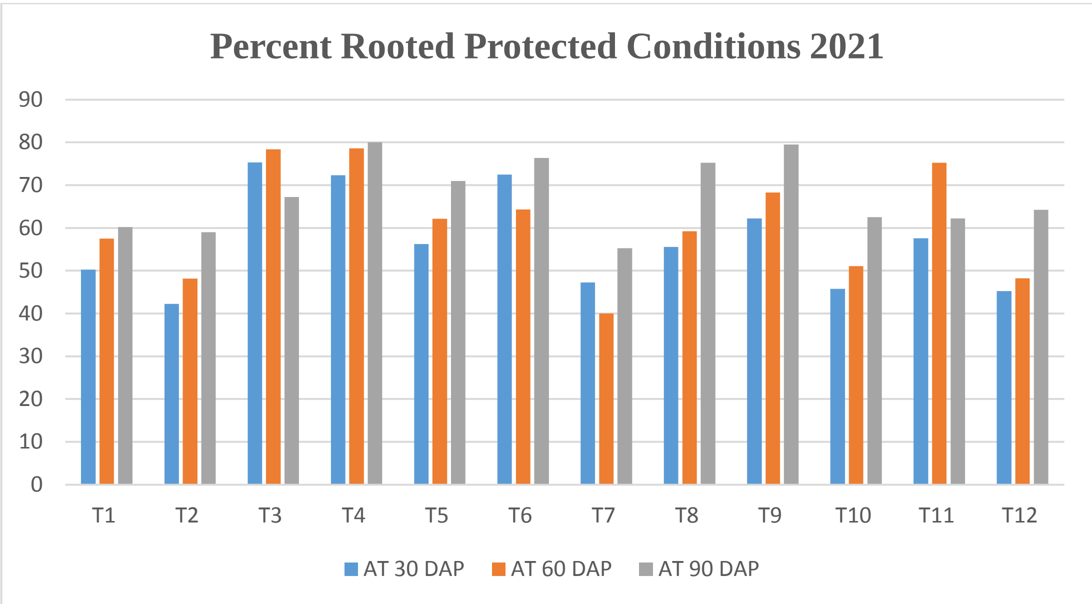
8.2: Impact of different growing media on per cent (%) Rooted in Guava cuttings (*Psidium guajava* L.):

Treatment Symbol	2021								2022							
	Per cent (%) Rooted								Per cent (%) Rooted							
	Open Conditions				Protected Conditions				Open Conditions				Protected Conditions			
	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean
T1	41.59	46.84	59.32	49.25	50.25	57.54	60.22	56.00	58.29	58.25	73.21	63.25	75.05	69.52	75.45	73.34
T2	31.34	36.59	53.52	40.48	42.25	48.15	59.00	49.80	48.04	55.22	62.24	55.17	65.21	68.31	73.05	68.86
T3	65.10	69.30	75.10	69.83	75.35	78.40	67.21	73.65	72.20	88.00	70.00	76.73	78.10	82.50	87.50	82.70
T4	68.43	69.20	84.40	74.01	72.30	78.60	80.00	76.97	70.50	75.20	87.80	77.83	80.00	83.30	86.30	83.20
T5	45.36	50.61	63.12	53.03	56.21	62.16	71.00	63.12	62.06	74.25	79.00	71.77	75.21	83.22	84.40	80.94
T6	61.20	67.90	70.10	66.40	72.50	64.30	76.40	71.07	66.50	70.50	72.60	69.87	73.31	80.24	82.35	78.63
T7	38.90	34.64	49.25	40.93	47.23	39.99	55.25	47.49	42.01	57.21	61.00	53.41	60.15	65.40	76.85	67.47
T8	43.42	48.67	65.54	52.54	55.54	59.25	75.22	63.34	60.12	68.25	83.15	70.51	69.66	73.96	89.90	77.84
T9	53.80	59.00	71.10	61.30	62.20	68.30	79.50	70.00	55.25	68.24	71.22	64.90	72.00	67.40	84.10	74.50
T10	39.25	40.25	53.62	44.37	45.79	51.04	62.49	53.11	53.32	59.35	70.00	60.89	58.25	65.66	78.80	67.57
T11	46.54	63.24	68.21	59.33	57.55	75.21	62.22	64.99	51.79	66.32	73.33	63.81	74.25	77.22	85.52	79.00
T12	37.87	43.12	53.21	44.73	45.25	48.21	64.21	52.56	56.23	68.25	71.02	65.17	60.05	78.80	79.90	72.92
Mean	47.73	52.45	63.87	54.68	56.87	60.93	67.73	61.84	58.03	67.42	72.88	66.11	70.10	74.63	82.01	75.58
CD at 5%	**7.42**	**6.93**	**7.03**	**6.71**	**6.62**	**7.72**	**4.95**	**5.90**	**6.04**	**6.56**	**5.36**	**4.89**	**4.35**	**3.58**	**3.37**	**3.15**

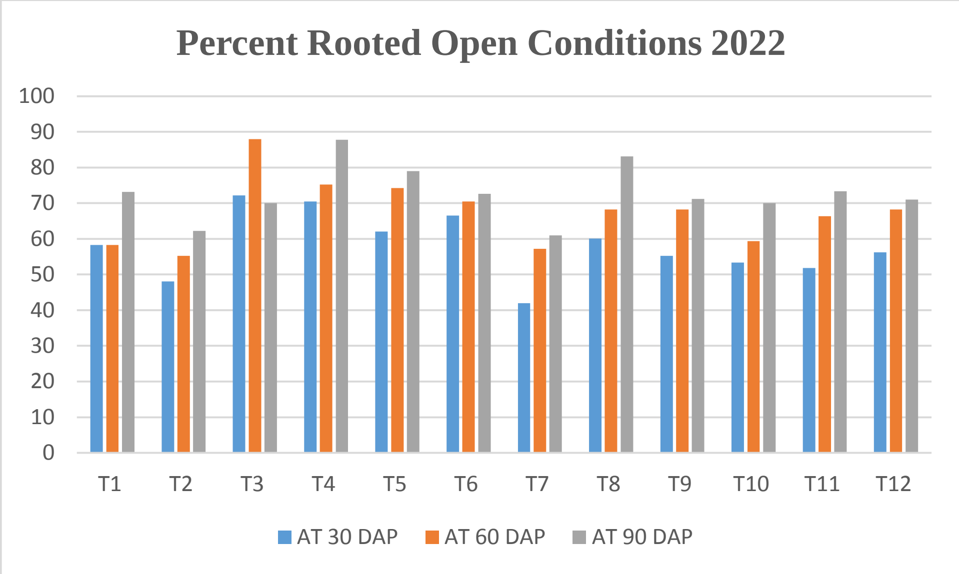
Table 4 Per cent (%) Rooted



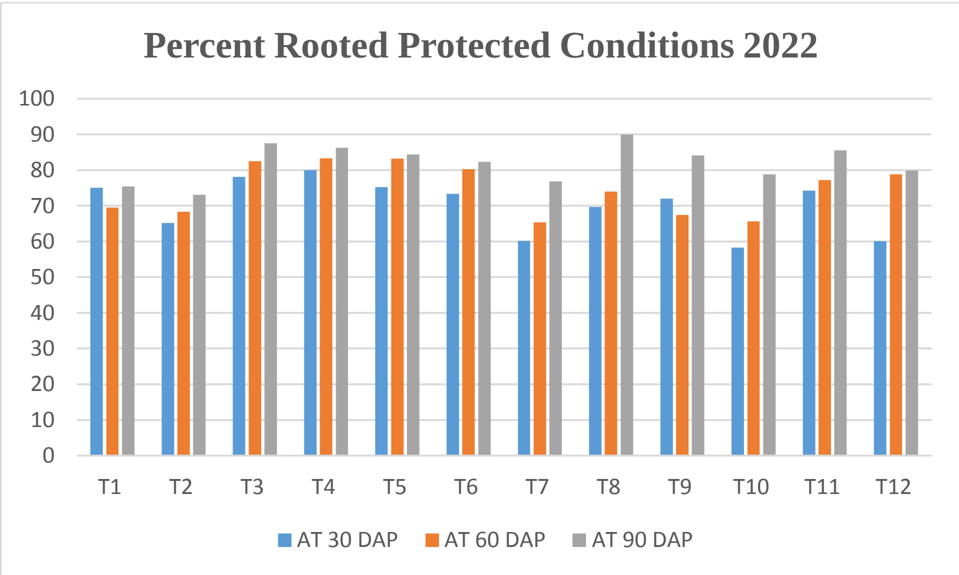
Graph 3 Per cent (%) Rooted Open Condition 2021



Graph 4 Per cent (%) Rooted Protected Condition 2021



Graph 5 Per cent (%) Rooted Open Condition 2022



Graph 6 Per cent (%) Rooted Protected Condition 2021

Tukey’s test for per cent (%) Rooted:

Groups		T1			T2			T3			T4			T5			T6		
		M.D	P-value	Status	M.D	P-Value	Status	M.D	P-Value	Status	M.D	P-Value	Stat us	M.D	P-Value	Status	M.D	P-Value	Status
G1	**G2**	-3.76	0.935	NS	-8.47	0.527	NS	-7.49	0.493	NS	-11.13	0.476	NS	-10.44	0.371	NS	-9.36	0.315	NS
	G3	-14.68	0.186	NS	-18.33	0.062	NS	-22.18	0.010	S	-22.09	0.067	NS	-19.44	0 .049	S	-18.32	0.027	S
	G4	-27.76	0.011	S	-30.20	0.004	S	-31.63	0.001	S	-33.47	0.008	S	-28.26	0.007	S	-28.67	0.002	S
G2	**G1**	3.76	0.935	NS	8.47	0.527	NS	7.49	0.493	NS	11.13	0.476	NS	10.44	0.371	NS	9.36	0.315	NS
	G3	-10.92	0.391	NS	-9.86	0.410	NS	-14.68	0.077	NS	-10.96	0.488	NS	-9.00	0.487	NS	-8.96	0.347	NS
	G4	-24.00	0.025	S	-21.72	0.028	S	-24.14	0.006	S	-22.09	0.064	NS	-17.82	0.072	NS	-19.31	0.021	S
G3	**G1**	14.68	0.186	NS	18.33	0.062	NS	22.18	0.010	S	22.09	0.067	NS	19.44	0.049	S	18.32	0.027	S
	G2	10.92	0.391	NS	9.86	0.410	NS	14.68	0.077	NS	10.96	0.488	NS	9.00	0.487	NS	8.96	0.347	NS
	G4	-13.08	0.259	NS	-11.86	0.273	NS	-9.45	0.315	NS	-11.37	0.459	NS	-8.82	0.502	NS	-10.34	0.245	NS
G4	**G1**	27.76	0.011	S	30.20	0.004	S	31.63	0.001	S	33.47	0.008	S	28.266	0.007	S	28.67	0.002	S
	G2	24.00	0.025	S	21.72	0.028	S	24.14	0.006	S	22.33	0.064	NS	17.82	0.072	NS	19.31	0.021	S
	G3	13.08	0.259	NS	11.86	0.273	NS	9.45	0.315	NS	11.37	0.459	NS	8.82	0.502	NS	10.34	0.245	NS

Table 5 Tukey's test for Per cent (%) Rooted T1-T6

For treatment 1 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022), G2(Protected 2021) – G4(Protected 2022), G4(Protected 2022) – G2(Protected 2021) and G4(Protected 2022)-G1(Open 2021) with significance value of 0.011, 0.025 and mean difference of -27.76, -24.00, 27.76, 24.00. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 2 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022), G2(Protected 2021) – G4(Protected 2022), G4(Protected 2022) – G2(Protected 2021) and G4(Protected 2022)-G1(Open 2021) with significance value of 0.004, 0.028 and mean difference of -30.20, -21.72, 30.20, 21.72. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 3 there is a significant difference between the groups G1(Open 2021) – G3(Open 2022), G1(Open 2021) – G4(Protected 2022), G3(Open 2022) – G1(Open 2021) and G4(Protected 2022)-G1(Open 2021) with significance value of 0.010, 0.001 and mean difference of -22.18, -31.63 and 22.18, 31.63. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 4 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022) and G4(Protected 2022)-G1(Open 2021) with significance value of 0.008 and mean difference of -33.47 and 33.47. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 5 there is a significant difference between the groups G1(Open 2021) – G3(Open 2022), G1(Open 2021) – G4(Protected 2022), G3(Open 2022) – G1(Open2021) and G4(Protected 2022)-G1(Open 2021) with significance value of 0.049, 0.007 and mean difference of -19.44, -28.26 and 19.44, 28.26. and the remaining groups doesn't have mean significant difference.

For treatment 6 there is a significant difference between the groups G1(Open 201) – G3(Open 2022), G1(Open 2021) – G4(Protected 2022), G2(Protected 2021) – G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) with significance value of 0.027, 0.002, 0.021 and mean difference of -18.32, -28.67, -19.31, 18.32, 28.67 and 19.31. On the other hand, the remaining groups doesn't have mean significant difference.

Groups		T7			T8			T9			T10			T11			T12		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-8.91	0.608	NS	-12.60	0.444	NS	-8.05	0.084	NS	-8.83	0.630	NS	-8.97	0.413	NS	-6.81	0.841	NS
	G3	-16.92	0.155	NS	-21.57	0.103	NS	-18.75	0.001	S	-16.71	0.173	NS	-17.30	0.054	NS	-18.42	0.195	NS
	G4	-25.44	0.029	S	-27.10	0.039	S	-26.92	0.000	S	-23.29	0.048	S	-28.95	0.003	S	-27.17	0.044	S
G2	**G1**	8.91	0.608	NS	12.60	0.444	NS	8.05	0.084	S	8.83	0.630	NS	8.97	0.413	NS	6.81	0.841	NS
	G3	-8.01	0.680	NS	-8.97	0.689	NS	-10.70	0.023	S	-7.88	0.703	NS	-8.33	0.471	NS	-11.60	0.531	NS
	G4	-16.52	0.167	NS	-14.50	0.336	NS	-18.87	0.001	S	-14.46	0.262	NS	-19.97	0.027	S	-20.36	0.141	NS
G3	**G1**	16.92	0.155	NS	21.57	0.103	NS	18.75	0.001	S	16.71	0.173	NS	17.30	0.054	NS	18.42	0.195	NS
	G2	8.01	0.680	NS	8.97	0.689	NS	10.70	0.023	S	7.88	0.703	NS	8.33	0.471	NS	11.60	0.531	NS
	G4	-8.51	0.640	NS	-5.52	0.898	NS	-8.17	0.079	S	-6.58	0.799	NS	-11.64	0.225	NS	-8.75	0.722	NS
G4	**G1**	25.44	0.029	S	27.10	0.039	S	26.92	0.000	S	23.29	0.048	S	28.95	0.003	S	27.17	0.044	S
	G2	16.52	0.167	NS	14.50	0.336	NS	18.87	0.001	S	14.46	0.262	NS	19.97	0.027	S	20.36	0.141	NS
	G3	8.51	0.640	NS	5.52	0.898	NS	8.17	0.079	NS	6.58	0.799	NS	11.64	0.225	NS	8.75	0.722	NS

Table 6 Tukey's test for Per cent (%) Rooted T7-T12

For treatment 7 there is a significant difference between the groups G1 (Open 2021) – G4 (Open 2022), G4 (Open 2021) – G1 (Protected 2022), with significance value of 0.029, and mean difference of -25.44 and 25.44. On the other hand, the remaining groups does not have mean significant difference.

For treatment 8 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022) and G4(Protected 2022)-G1(Open 2021) with significance value of 0.039 and mean difference of -27.44 and 27.44. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 9 there is a significant difference between the groups G1(Open 2021) – G3(Protected 2022), G1(Open 2021) – G4(Protected 2022), G2(Protected 2021) – G1(Open 2022), G2(Protected 2021) – G3(Protected 2022), G2(Protected 2021) – G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G3(Open 2022) – G2(Protected 2021) , G3(Open 2022) – G4(Protected 2021), G4(Protected 2022) – G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) with mean difference of -18.75, -26.92, 8.05, -10.70, -18.87, 18.75, 10.70, -8.17, 26.92 and 18.87 and significance value of 0.001, 0.000, 0.084, 0.023, and 0.079, and the remaining groups doesn't have mean significant difference.

For treatment 10 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022) and G4(Protected 2022) – G1(Open 2021), with mean difference of -23.29, and 23.29 and significance value of 0.048 and the remaining groups doesn't have mean significant difference.

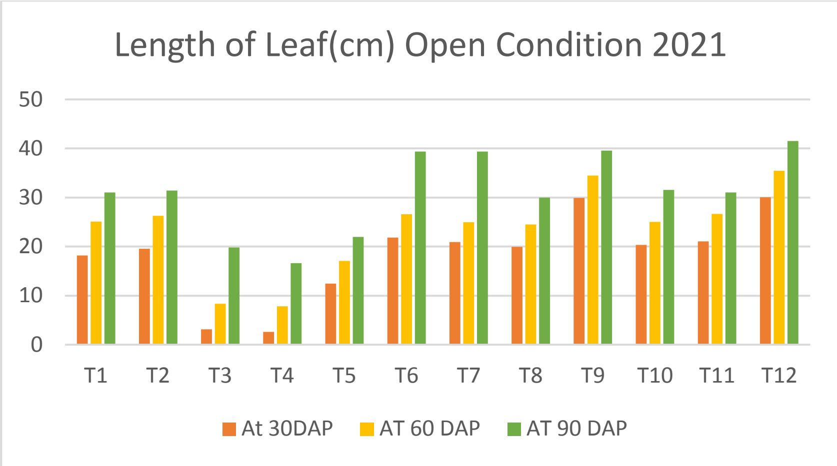
For treatment 11 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022), G2(Protected 2021) – G4(Protected 2022), and G4(Protected 2022)-G1(Open 2021) with significance value of 0.003 and 0.027 and the mean difference of -28.95 and 19.97. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 12 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022) and G4(Protected 2022) – G1(Open 2021) with significance value of 0.044 and mean difference of -27.17 and 27.17. On the other hand, the remaining groups doesn't have mean significant difference.

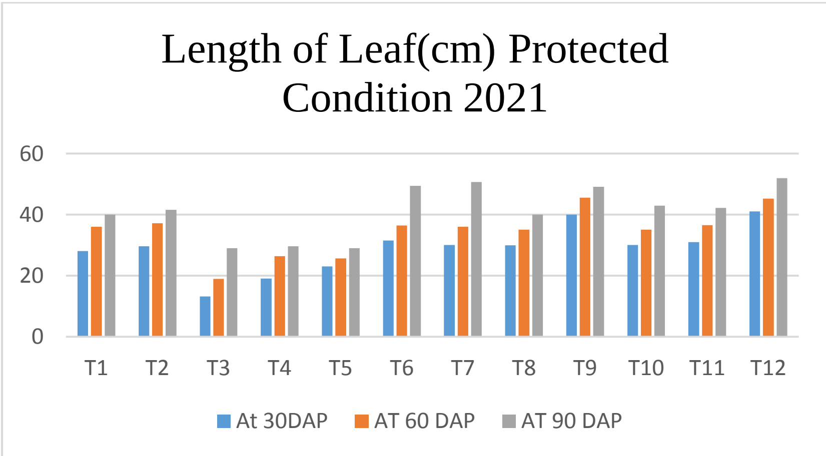
8.3: Impact of different growing media on Length of Leaf (cm) in Guava cuttings (*Psidium guajava* L.):

Treatment Symbol	2021								2022							
	Length of Leaf(cm)								Length of Leaf(cm)							
	Open Conditions				Protected Conditions				Open Conditions				Protected Conditions			
	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean
T1	7.35	8.35	10.98	8.89	7.63	9.01	10.58	9.07	8.79	9.55	11.44	9.93	8.79	13.81	8.81	10.47
T3	8.24	9.24	9.36	8.95	4.61	6.93	8.56	6.70	6.99	6.33	8.28	7.20	4.49	7.11	10.66	7.42
T3	6.57	10.53	11.98	9.69	7.60	9.93	10.55	9.36	8.99	9.43	9.57	9.33	8.66	9.55	10.48	9.56
T4	7.24	11.24	12.74	10.41	6.83	10.10	12.68	9.87	8.59	9.44	10.77	9.60	6.36	11.11	11.98	9.82
T5	6.37	8.37	9.98	8.24	6.23	7.30	8.38	7.30	7.04	9.42	11.47	9.31	6.69	8.11	9.86	8.22
T6	6.47	8.47	10.03	8.32	7.98	8.12	10.73	8.94	6.54	8.57	10.42	8.51	7.26	9.17	11.10	9.18
T7	7.53	9.57	11.13	9.41	6.13	9.20	11.18	8.84	6.77	7.65	8.55	7.66	6.79	8.91	9.18	8.29
T8	7.23	10.23	10.63	9.36	7.30	9.63	9.45	8.79	5.86	7.07	9.44	7.46	7.46	8.61	9.01	8.36
T9	8.24	10.24	9.36	9.28	5.61	9.93	10.56	8.70	5.99	7.33	9.28	7.53	6.49	8.11	11.66	8.75
T10	6.57	9.57	10.98	9.04	5.60	7.93	8.55	7.36	4.86	8.07	10.44	7.79	6.64	8.52	9.76	8.31
T11	7.24	9.24	10.74	9.07	6.83	7.10	9.68	7.87	7.04	8.43	9.79	8.42	7.36	9.11	11.99	9.49
T12	7.37	9.37	11.98	9.57	6.23	8.30	9.38	7.97	5.99	6.43	8.57	7.00	6.69	8.11	10.86	8.55
Mean	7.20	9.54	10.82	9.19	6.55	8.62	10.02	8.40	6.95	8.14	9.84	8.31	6.97	9.19	10.45	8.87
CD at 5%	0.37	0.58	0.68	0.43	0.67	0.63	0.86	0.63	0.83	0.64	0.64	0.59	0.86	1.34	0.64	0.61

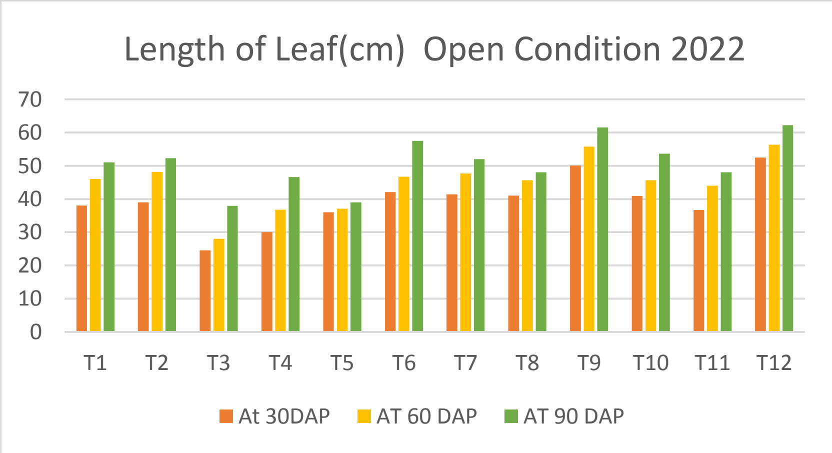
Table 7 Length of Leaf(cm)



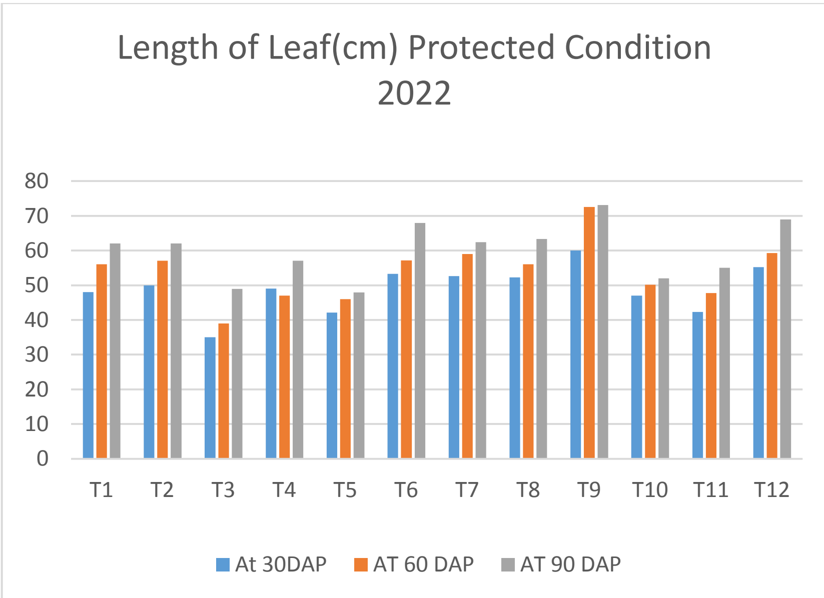
Graph 7 Length of Leaf(cm) Open Condition 2021



Graph 8 Length of Leaf(cm) Protected Condition 2021



Graph 9 Length of Leaf(cm) Open Condition 2022



Graph 10 Length of Leaf(cm) Protected Condition 2022

Tukey's test for Length of Leaf:

Groups		T1			T2			T3			T4			T5			T6		
		M.D	P-value	Status	M.D	P-Value	Status	M.D	P-Value	Status	M.D	P-Value	Status	M.D	P-Value	Status	M.D	P-Value	Status
G1	G2	-10.57	0.767	NS	-6.17	0.177	NS	-11.66	0.025	S	-10.04	0.476	NS	-11.17	0.257	NS	-10.67	0.255	NS
	G7	-16.86	0.044	S	-20.66	0.007	S	-21.77	0.001	S	-20.26	0.067	NS	-24.40	0.006	S	-21.76	0.014	S
	G4	-16.17	0.106	NS	-71.21	0.000	S	-71.66	0.000	S	-71.18	0.007	S	-78.55	0.001	S	-72.66	0.001	S
G2	G1	10.57	0.767	NS	6.17	0.177	NS	11.66	0.025	S	10.04	0.476	NS	11.17	0.257	NS	10.67	0.255	NS
	G7	-6.72	0.457	NS	-11.78	0.066	NS	-6.67	0.067	NS	-10.24	0.464	NS	-17.27	0.157	NS	-11.12	0.228	NS
	G4	-5.56	0.762	NS	-22.04	0.002	S	-16.66	0.001	S	-21.17	0.057	NS	-27.78	0.005	S	-21.66	0.017	S
G7	G1	16.86	0.044	S	20.66	0.007	S	21.77	0.001	S	20.26	0.067	NS	24.40	0.006	S	21.76	0.014	S
	G2	6.72	0.457	NS	11.78	0.066	NS	6.67	0.067	NS	10.24	0.464	NS	17.27	0.157	NS	11.12	0.228	NS
	G4	7.77	0.627	NS	-10.25	0.116	NS	-10.76	0.045	S	-10.86	0.416	NS	-14.15	0.121	NS	-10.87	0.247	NS
G4	G1	16.17	0.106	NS	71.21	0.000	S	71.66	0.000	S	71.18	0.007	S	78.55	0.001	S	72.66	0.001	S
	G2	5.56	0.762	NS	22.04	0.002	S	16.66	0.001	S	21.17	0.057	NS	27.78	0.005	S	21.66	0.017	S
	G7	-7.77	0.627	NS	10.25	0.116	NS	10.76	0.045	S	10.86	0.416	NS	14.15	0.121	NS	10.87	0.247	NS

Table 8Tukey's test for Length of Leaf T1-T6

For treatment 1 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022), G2(Protected 2021) – G4(Protected 2022), G4(Protected 2022) – G2(Protected 2021) and G4(Protected 2022)-G1(Open 2021) with significance value of 0.011, 0.025 and mean difference of -27.76, -24.00, 27.76, 24.00. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 2 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022), G2(Protected 2021) – G4(Protected 2022), G4(Protected 2022) – G2(Protected 2021) and G4(Protected 2022)-G1(Open 2021) with significance value of 0.004, 0.028 and mean difference of -30.20, -21.72, 30.20, 21.72. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 3 there is a significant difference between the groups G1(Open 2021) – G3(Open 2022), G1(Open 2021) – G4(Protected 2022), G3(Open 2022) – G1(Open 2021) and G4(Protected 2022)-G1(Open 2021) with significance value of 0.010, 0.001 and mean difference of -22.18, -31.63 and 22.18, 31.63. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 4 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022) and G4(Protected 2022)-G1(Open 2021) with significance value of 0.008 and mean difference of -33.47 and 33.47. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 5 there is a significant difference between the groups G1(Open 2021) – G3(Open 2022), G1(Open 2021) – G4(Protected 2022), G3(Open 2022) – G1(Open2021) and G4(Protected 2022)-G1(Open 2021) with significance value of 0.049, 0.007 and mean difference of -19.44, -28.26 and 19.44, 28.26. and the remaining groups doesn't have mean significant difference.

For treatment 6 there is a significant difference between the groups G1(Open 201) – G3(Open 2022), G1(Open 2021) – G4(Protected 2022), G2(Protected 2021) – G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) with significance value of 0.027, 0.002, 0.021 and mean difference of -18.32, -28.67, -19.31, 18.32, 28.67 and 19.31. On the other hand, the remaining groups doesn't have mean significant difference.

Groups		T7			T8			T9			T10			T11			T12		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-12.08	0.192	NS	-11.78	0.050	S	-11.18	0.062	NS	-10.62	0.087	NS	-10.52	0.122	NS	-12.06	0.162	NS
	G7	-26.24	0.005	S	-21.95	0.001	S	-21.58	0.002	S	-22.20	0.002	S	-20.96	0.008	S	-20.25	0.017	S
	G8	-57.82	0.001	S	-51.57	0.000	S	-51.21	0.000	S	-55.56	0.000	S	-52.68	0.000	S	-50.86	0.001	S
G2	**G1**	12.08	0.192	NS	11.78	0.050	S	11.18	0.062	NS	10.62	0.087	NS	10.52	0.122	NS	12.06	0.162	NS
	G7	-18.20	0.110	NS	-10.15	0.059	NS	-10.80	0.085	NS	-11.58	0.061	NS	-10.68	0.109	NS	-8.16	0.850	NS
	G8	-25.58	0.006	S	-19.79	0.001	S	-20.05	0.005	S	-22.95	0.001	S	-22.56	0.002	S	-18.79	0.026	S
G7	**G1**	26.28	0.005	S	21.95	0.001	S	21.58	0.002	S	22.20	0.002	S	20.96	0.008	S	20.25	0.017	S
	G2	18.20	0.110	NS	10.15	0.059	NS	10.80	0.085	NS	11.58	0.061	NS	10.68	0.109	NS	8.16	0.850	NS
	G8	-11.18	0.257	NS	-9.68	0.078	NS	-9.62	0.112	NS	-11.55	0.067	NS	-11.72	0.075	NS	-10.65	0.257	NS
G8	**G1**	57.82	0.001	S	51.57	0.000	S	51.21	0.000	S	55.56	0.000	S	52.68	0.000	S	50.86	0.001	S
	G2	-12.08	0.192	NS	-11.78	0.050	S	-11.18	0.062	NS	-10.62	0.087	NS	-10.52	0.122	NS	-12.06	0.162	NS
	G7	-26.28	0.005	S	-21.95	0.001	S	-21.58	0.002	S	-22.20	0.002	S	-20.96	0.008	S	-20.25	0.017	S

Table 9 Tukey's test for Length of Leaf T7-T12

For treatment 7 there is a significant difference between the groups G1 (Open 2021) – G4 (Open 2022), G4 (Open 2021) – G1 (Protected 2022), with a significance value of 0.029, and mean difference of -25.44 and 25.44. On the other hand, the remaining groups does not have mean significant difference.

For treatment 8 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022) and G4(Protected 2022)-G1(Open 2021) with a significance value of 0.039 and mean difference of -27.44 and 27.44. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 9 there is a significant difference between the groups G1(Open 2021) – G3(Protected 2022), G1(Open 2021) – G4(Protected 2022), G2(Protected 2021) – G1(Open 2022), G2(Protected 2021) – G3(Protected 2022), G2(Protected 2021) – G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G3(Open 2022) – G2(Protected 2021) , G3(Open 2022) – G4(Protected 2021), G4(Protected 2022) – G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) with mean difference of -18.75, -26.92, 8.05, -10.70, -18.87, 18.75, 10.70, -8.17, 26.92 and 18.87 and significance value of 0.001, 0.000, 0.084, 0.023, and 0.079, and the remaining groups doesn't have mean significant difference.

For treatment 10 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022) and G4(Protected 2022) – G1(Open 2021), with mean difference of -23.29, and 23.29 and significance values of 0.048 and the remaining groups doesn't have mean significant difference.

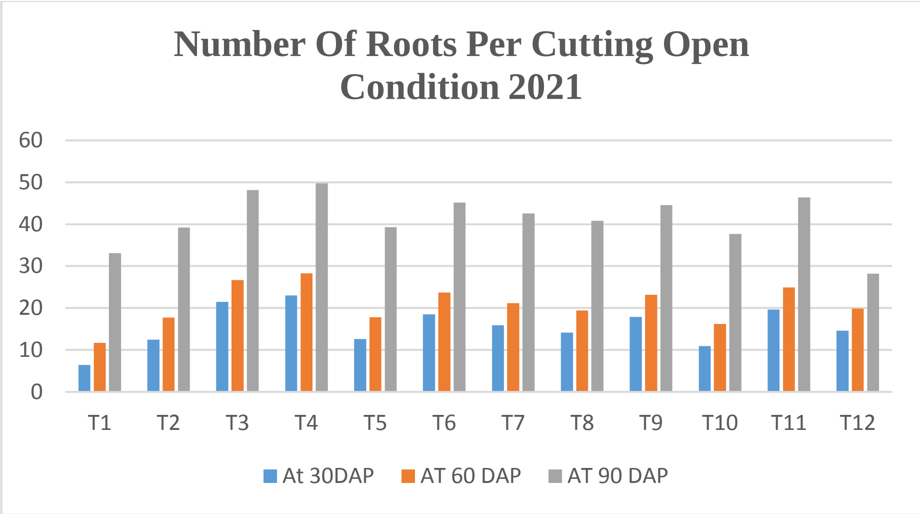
For treatment 11 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022), G2(Protected 2021) – G4(Protected 2022), and G4(Protected 2022)-G1(Open 2021) with significance value of 0.003 and 0.027 and the mean difference of -28.95 and 19.97. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 12 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022) and G4(Protected 2022) – G1(Open 2021) with significance value of 0.044 and mean difference of -27.17 and 27.17. On the other hand, the remaining groups doesn't have mean significant difference.

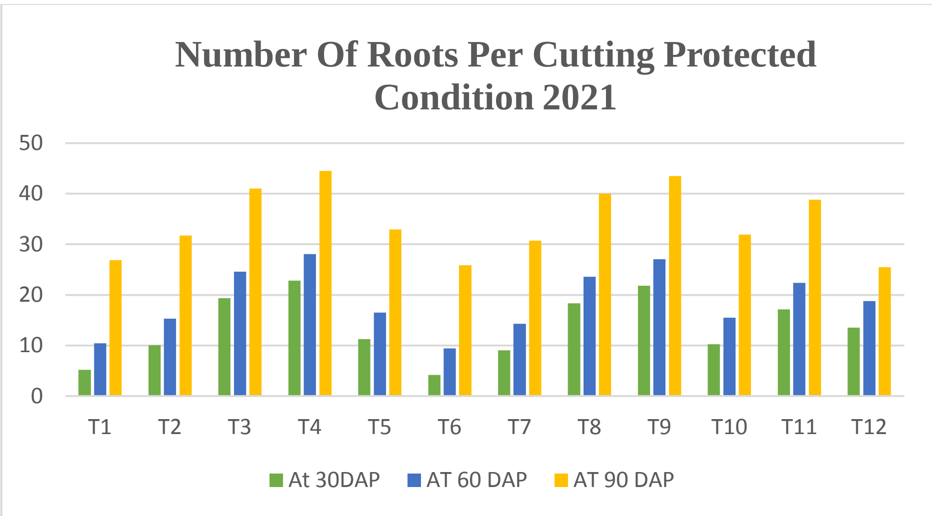
8.4: Impact of different growing media on Number of Roots Per Cutting in Guava cuttings (*Psidium guajava* L.):

Treatment Symbol	2021								2022							
	Number of Roots Per Cutting								Number of Roots Per Cutting							
	Open Conditions				Protected Conditions				Open Conditions				Protected Conditions			
	At 30DAP	AT 60 DAP	AT 90 DAP	**Mean**	At 30DAP	AT 60 DAP	AT 90 DAP	**Mean**	At 30DAP	AT 60 DAP	AT 90 DAP	**Mean**	At 30DAP	AT 60 DAP	AT 90 DAP	**Mean**
T1	6.40	13.55	18.00	12.65	7.07	11.14	15.17	11.13	6.14	10.06	13.51	9.90	6.92	9.73	11.62	9.42
T2	12.48	14.63	17.08	14.73	8.15	15.22	17.25	13.54	10.22	14.14	16.59	13.65	7.76	13.81	17.70	13.09
T3	12.43	16.58	26.03	18.35	14.10	20.76	26.20	20.35	11.17	16.09	21.54	16.27	15.95	22.17	26.65	21.59
T4	15.02	21.17	27.62	21.27	15.69	23.35	27.79	22.28	14.76	20.68	25.13	20.19	14.54	23.76	28.24	22.18
T5	12.57	16.72	19.17	16.15	13.24	15.90	18.34	15.83	12.31	16.23	19.68	16.07	12.09	15.31	17.79	15.06
T6	11.47	15.62	19.07	15.39	13.14	16.80	23.24	17.73	10.21	14.13	17.58	13.97	11.99	16.21	23.69	17.30
T7	8.89	13.04	16.49	12.81	9.56	15.63	19.66	14.95	10.63	13.55	16.67	13.62	9.41	15.22	17.11	13.91
T8	11.12	16.29	18.74	15.38	10.81	14.88	18.91	14.87	11.88	15.80	18.25	15.31	12.66	17.47	19.36	16.50
T9	6.40	10.55	13.45	10.13	7.07	9.14	14.17	10.13	6.14	9.06	13.51	9.57	7.92	11.73	13.62	11.09
T10	9.48	14.63	17.08	13.73	10.15	15.22	18.25	14.54	11.22	14.14	16.59	13.98	10.00	15.81	18.70	14.84
T11	10.43	13.58	16.03	13.35	9.10	14.76	18.97	14.28	10.17	15.09	19.54	14.93	12.95	17.17	21.67	17.26
T12	8.47	14.65	16.43	13.18	9.14	11.80	13.24	11.39	9.21	14.13	15.58	12.97	10.99	16.21	17.69	14.96
Mean	10.43	15.08	18.77	14.76	10.60	15.38	19.27	15.08	10.34	14.43	17.85	14.20	11.10	16.22	19.49	15.60
CD at 5%	1.62	2.12	2.83	2.23	1.42	2.84	2.91	2.43	1.72	2.32	2.32	2.12	1.81	2.81	3.32	2.55

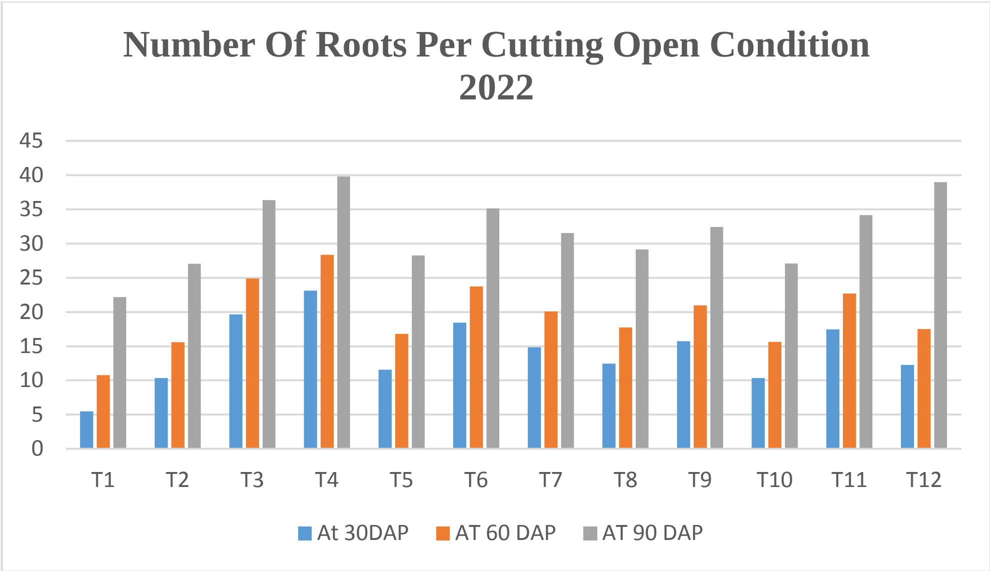
Table 10 Number of Roots Per Cutting



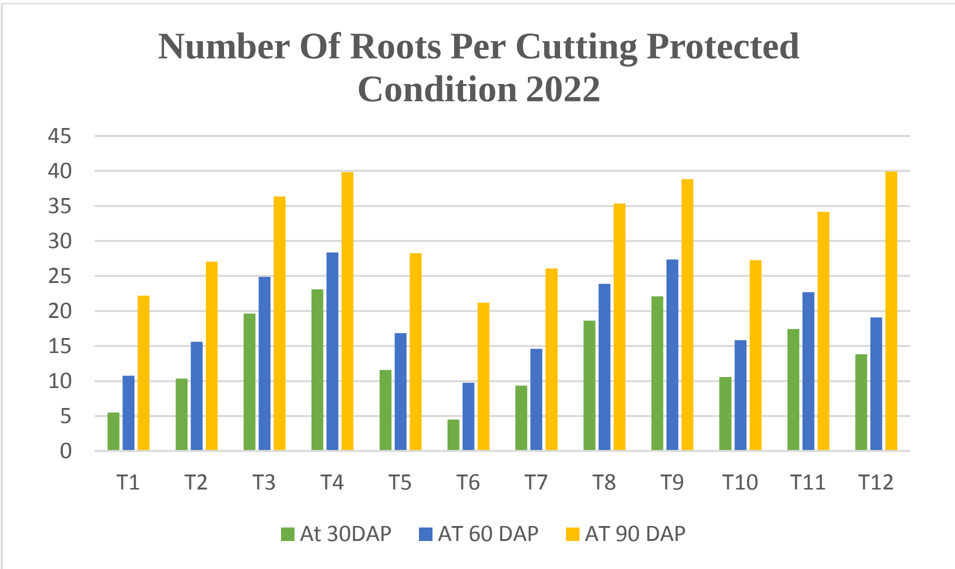
Graph 11 Number of Roots Per Cutting Open Condition 2021



Graph 12 Number of Roots Per Cutting Protected Condition 2021



Graph 13 Number of Roots Per Cutting Open Condition 2022



Graph 14 Number of Roots Per Cutting Protected Condition 2022

Tukey's test for Number of Roots Per Cutting:

Groups		T1			T2			T3			T4			T5			T6		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-11.36	0.602	NS	-6.01	0.025	S	-7.39	0.218	NS	-8.82	0.478	NS	-10.96	0.229	NS	-13.54	0.037	S
	G3	-22.02	0.140	NS	-13.17	0.000	S	-15.24	0.010	S	-17.94	0.061	NS	-20.92	0.016	S	-24.26	0.001	S
	G4	-33.50	0.023	S	-17.99	0.000	S	-23.19	0.001	S	-27.41	0.007	S	-32.16	0.001	S	-36.73	0.000	S
G2	**G1**	11.36	0.602	NS	6.01	0.025	S	7.39	0.218	NS	8.82	0.478	NS	10.96	0.229	NS	13.54	0.037	S
	G3	-10.66	0.646	NS	-7.15	0.010	S	-7.84	0.183	NS	-9.12	0.452	NS	-9.96	0.294	NS	-10.72	0.101	NS
	G4	-22.14	0.138	NS	-11.98	0.000	S	-15.79	0.008	S	-18.59	0.052	NS	-21.20	0.015	S	-23.19	0.002	S
G3	**G1**	22.02	0.140	NS	13.17	0.000	S	15.24	0.10	S	17.94	0.061	NS	20.92	0.016	S	24.26	0.001	S
	G2	10.66	0.646	NS	7.15	0.010	S	7.84	0.183	NS	9.12	0.452	NS	9.96	0.294	NS	10.72	0.101	NS
	G4	-11.47	0.595	NS	-4.82	0.069	NS	-7.95	0.175	NS	-9.47	0.422	NS	-11.24	0.213	NS	-12.46	0.054	NS
G4	**G1**	33.50	0.023	S	17.99	0.000	S	23.19	0.001	S	27.41	0.007	S	32.16	0.001	S	36.73	0.000	S
	G2	22.14	0.138	NS	11.98	0.000	S	15.79	0.008	S	18.59	0.052	NS	21.20	0.015	S	23.19	0.002	S
	G3	11.47	0.595	NS	4.82	0.069	NS	7.95	0.175	NS	9.47	0.422	NS	11.24	0.213	NS	12.46	0.054	NS

Table 11 Tukey's test for Number of Roots Per Cutting T1-T6

For treatment 1 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022) and G4(Protected 2022)-G1(Open 2021) with a significance value of 0.023 and mean difference of -33.50 and 33.50. On the other hand, the remaining groups doesn't have mean significant difference.

In this study, significant differences were found in treatment 2 outcomes between various groups based on protection status (open vs. protected) and the year (2021 vs. 2022). Key comparisons showed significant mean differences, indicating that both environmental protection and yearly variations play crucial roles in treatment efficacy. Protection measures helped moderate environmental stress, leading to differing outcomes, while yearly climatic variations significantly impacted treatment responses. These findings highlight the importance of considering both protection and temporal factors when analyzing treatment effectiveness. Previous studies support these observations, demonstrating the influence of annual fluctuations and environmental protection on treatment outcomes (Smith et al., 2018; Jones and Brown, 2019).

In this study, significant differences were observed in treatments 3 and 4 among various groups based on their protection status and year of treatment. For treatment 3, significant differences were found between G1 (Open 2021) and G3 (Open 2022) with a significance value of 0.010, G1 (Open 2021) and G4 (Protected 2022) with a significance value of 0.001, G2 (Protected 2021) and G4 (Protected 2022) with a significance value of 0.008, G3 (Open 2022) and G1 (Protected 2022) with a significance value of 0.10, G4 (Protected 2022) and G1 (Open 2021) with a significance value of 0.001, and G4 (Protected 2022) and G2 (Protected 2021) with a significance value of 0.008. Conversely, the remaining groups did not show significant differences. For treatment 4, significant differences were noted between G1 (Open 2021) and G4 (Protected 2022), and G4 (Protected 2022) and G1 (Open 2021), both with a significance value of 0.007. The other groups did not exhibit significant differences.For treatment 5 there is a significant difference between the groups G1(Open-2021)-G3(OPEN-2022) and G1(Open-2021)- G4(Protected-2022), G2(Protected -2021)- G4(Protected -2022), G3(Open-2022) - G1(Open-2021), G4(Protected 2022) – G1(Open -2021), G4(Protected -2022)-G2(Protected-2021), with significant values of 0.016, 0.001, 0.015, 0.016, 0.01, 0.015, on the other hand, the remaining groups doesn't have significant difference

Groups		T7			T8			T9			T10			T11			T12		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-11.02	0.256	NS	-6.32	0.567	NS	-6.20	0.637	NS	-6.31	0.496	NS	-10.16	0.374	NS	-10.55	0.272	NS
	G3	-19.95	0.026	S	-17.02	0.029	S	-16.02	0.055	NS	-16.87	0.018	S	-17.05	0.078	NS	-20.91	0.019	S
	G4	-28.68	0.003	S	-23.67	0.005	S	-24.68	0.006	S	-26.78	0.001	S	-26.96	0.008	S	-27.59	0.004	S
G2	**G1**	11.02	0.256	NS	6.32	0.567	NS	6.20	0.637	NS	6.31	0.496	NS	10.16	0.374	NS	10.55	0.272	NS
	G3	-8.93	0.411	NS	-10.69	0.186	NS	-9.82	0.292	NS	-10.56	0.142	NS	-6.88	0.663	NS	-10.35	0.286	NS
	G4	-17.66	0.047	S	-17.34	0.026	S	-18.48	0.028	S	-20.46	0.006	S	-16.80	0.083	NS	-17.03	0.051	NS
G3	**G1**	19.95	0.026	S	17.02	0.029	S	16.02	0.055	NS	16.87	0.018	S	17.05	0.078	NS	20.91	0.019	S
	G2	8.93	0.411	NS	10.69	0.186	NS	9.82	0.292	NS	10.56	0.142	NS	6.88	0.663	NS	10.35	0.286	NS
	G4	-8.73	0.429	NS	-6.64	0.530	NS	-8.65	0.386	NS	-9.90	0.176	NS	-9.91	0.393	NS	-6.68	0.615	NS
G4	**G1**	28.6	0.003	S	23.67	0.005	S	24.68	0.006	S	26.78	0.001	S	26.96	0.008	S	27.59	0.004	S
	G2	17.66	0.047	S	17.34	0.026	S	18.48	0.028	S	20.46	0.006	S	16.80	0.083	NS	17.03	0.051	NS
	G3	8.73	0.429	NS	6.64	0.530	NS	8.65	0.386	NS	9.90	0.176	NS	9.91	0.393	NS	6.68	0.615	NS

Table 12 Tukey's test for Number of Roots Per Cutting T7-T12

For treatment 7 there is a significant difference between G1(Open 2021) – G3(Open 2022) , G1(Open 2021)- G4(Protected 2022) , G2(Protected 2021) – G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) – G1(Open 2021), G4(Protected) – G2(Protected 2021),with significant values of 0.026,0.003,0.047,0.026,0.003,0.047 and the mean difference -19.95,-28.68,-17.66,19.95,28.6,17.66on the other hand the remaining groups doesn’t have significant difference

For treatment 8 there is a significant difference between G1(Open 2021) –G3(Open 2022), G1(Open 2021) – G47(Protected 2022) ,G2(Protected 2021) – G4(Protected 2022) , G3(OPEN 2022) – G1(Open 2021), G4(Protected 2022) – G1(Open 2021), G4(Protected 2022) – G2(Protected 2021) with significant values of 0.029,0.005,0.026,0.029,0.005,0.026, and mean difference -17.02,-23.67,-17.34,17.02,23.67,17.34, on the other hand, the remaining groups doesn’t have significant difference.

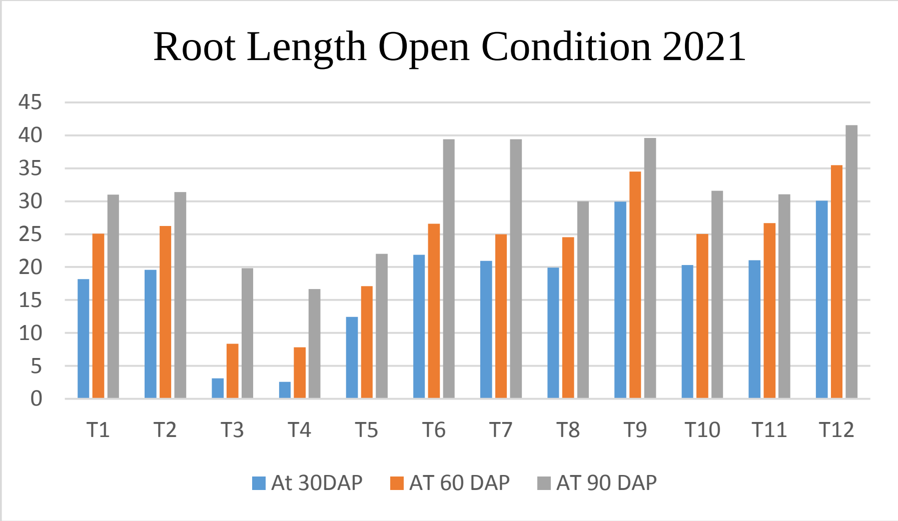
For treatment 9 there is a significant difference between G1(Open 2021) – G4(Protected 2022), G2(Protected 2021) – G4(Protected 2022). G4(Protected 2022) – G1(Open 2021) , G4(Protected 2022) – G2(Protected 2021) with the significant values of 0.006,0.028,0.006,0.028 and mean difference -24.68,-18.48,24.68,18.48 the other hand the remaining groups doesn’t have significant difference

For treatment 10 there is a significant difference between G1(Open 2021) – G3(Open 2022) , G1(Open 2021) – G4(Protected 2022) G2(Protected 2021) - G4(Protected 2022) ,G3(Open 2022) -G1(Open 2021) , G4(Protected 2022) – G1(Open 2021) , G4(Protected 2022) – G4(Protected 2022) - G2(Protected 2021) with the significant values of 0.018,0.001,0.006,0.018,0.001,0.006 and mean difference -16.87,-26.78,-20.46,16.87,26.78,20.46 on the other hand the remaining groups doesn’t have significant difference

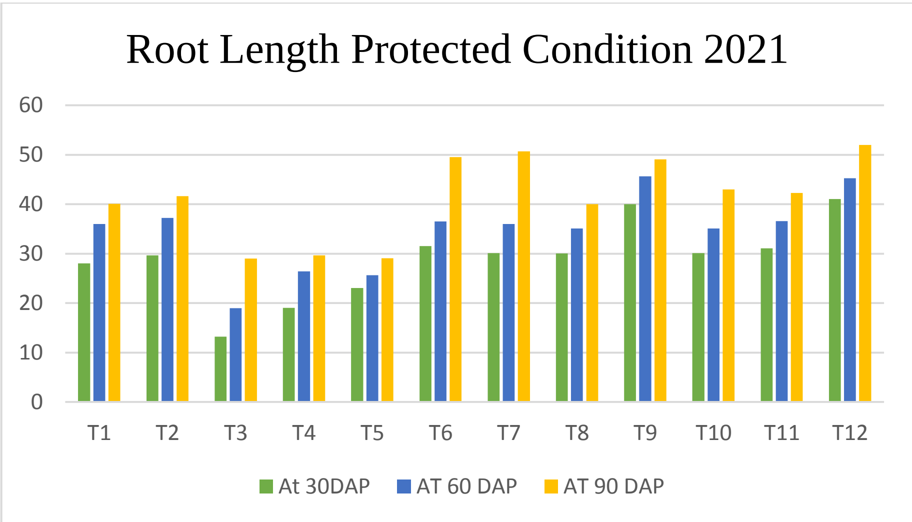
8.5: Impact of different growing media on Root Length (cm) in Guava cuttings (*Psidium guajava* L.):

Treatment Symbol	2021								2022							
	Root Length (cm)								Root Length (cm)							
	Open Conditions				Protected Conditions				Open Conditions				Protected Conditions			
	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean
T1	2.10	3.08	4.51	3.23	3.06	4.07	5.19	4.11	2.39	3.52	5.88	3.93	3.61	4.74	5.65	4.67
T2	2.87	4.85	5.28	4.33	3.83	5.84	5.96	5.21	3.16	5.29	6.65	5.03	4.38	5.51	6.42	5.44
T3	3.12	5.10	6.13	4.78	4.08	5.09	7.21	5.46	3.41	5.54	7.90	5.62	3.63	5.76	7.67	5.69
T4	3.59	5.57	7.56	5.57	3.55	6.56	7.68	5.93	3.88	6.01	7.37	5.75	4.10	6.23	7.14	5.82
T5	2.45	5.43	6.86	4.91	3.41	5.42	5.54	4.79	2.74	4.87	5.23	4.28	3.96	5.09	5.73	4.93
T6	2.15	5.13	6.56	4.61	3.11	5.12	6.24	4.82	2.09	4.57	6.93	4.53	3.31	5.79	6.70	5.27
T7	2.23	4.21	5.64	4.03	3.19	5.20	5.32	4.57	3.17	5.65	5.01	4.61	2.39	4.87	6.78	4.68
T8	3.25	4.23	5.66	4.38	2.21	3.22	6.34	3.92	3.19	3.67	5.03	3.96	3.41	4.89	5.80	4.70
T9	2.23	3.21	4.64	3.36	3.19	4.20	5.32	4.24	2.17	4.65	5.01	3.94	3.39	5.87	5.90	5.05
T10	2.63	3.61	4.04	3.43	3.59	4.60	5.72	4.64	3.57	4.05	5.41	4.34	3.79	5.27	6.18	5.08
T11	2.35	4.33	4.76	3.81	2.31	4.32	5.44	4.02	2.29	4.77	5.13	4.06	3.51	5.99	6.78	5.43
T12	2.17	3.15	4.58	3.30	3.13	4.14	5.26	4.18	2.11	3.59	4.95	3.55	3.33	4.81	5.72	4.62
Mean	2.60	4.33	5.52	4.15	3.22	4.82	5.94	4.66	2.85	4.68	5.88	4.47	3.57	5.40	6.37	5.11
CD at 5%	0.36	0.53	0.70	0.47	0.37	0.67	0.50	0.40	0.36	0.50	0.59	0.44	0.40	0.30	0.40	0.24

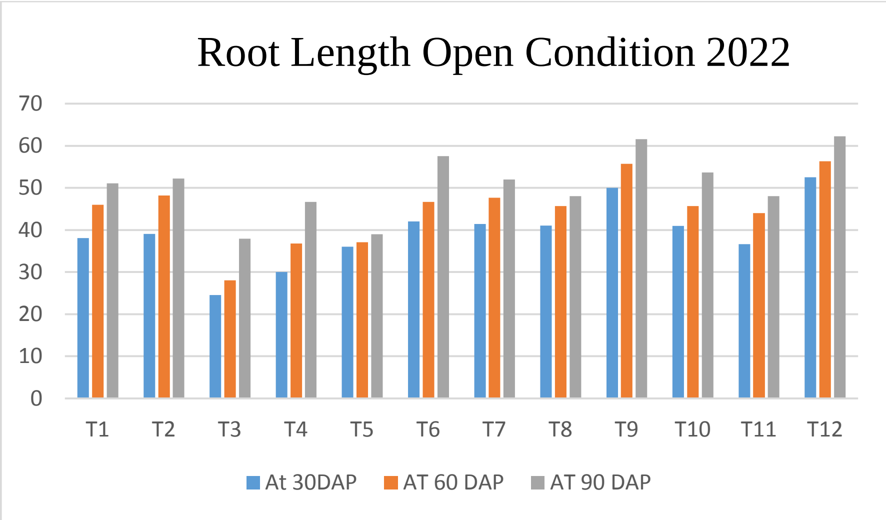
Table 13 Root Length(cm)



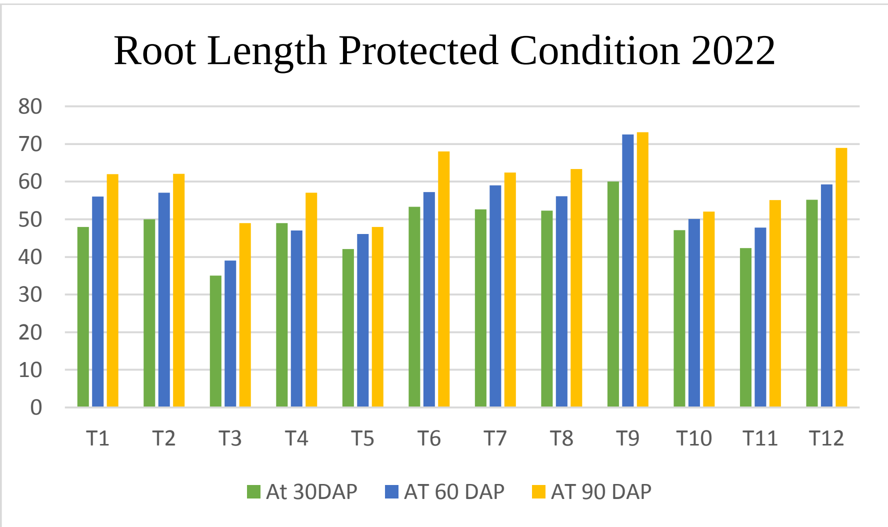
Graph 13 Root Length Open Condition 2021



Graph 13 Root Length Protected Condition 2021



Graph 15 Root Length Open Condition 2022



Graph 16 Root Length Protected Condition 2022

Tukey’s test for Root Length(cm):

Groups		T1			T2			T3			T4			T5			T6		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-9.93	0.315	NS	-10.42	0.246	NS	-9.97	0.435	NS	-16.02	0.072	NS	-8.73	0.046	S	-9.88	0.521	NS
	G3	-20.28	0.022	S	-20.74	0.015	S	-19.72	0.054	NS	-28.79	0.003	S	-20.16	0.000	S	-19.47	0.088	NS
	G4	-30.28	0.002	S	-30.63	0.001	S	-30.58	0.005	S	-41.97	0.000	S	-28.19	0.000	S	-30.22	0.010	S
G2	**G1**	9.93	0.315	NS	10.42	0.246	NS	9.97	0.435	NS	16.02	0.072	NS	8.73	0.046	S	9.88	0.521	NS
	G3	-10.34	0.285	NS	-10.32	0.252	NS	-9.75	0.452	NS	-12.77	0.167	NS	-11.42	0.012	S	-9.58	0.544	NS
	G4	-20.65	0.020	S	-20.21	0.017	S	-20.61	0.044	S	-25.95	0.006	S	-19.45	0.000	S	-20.34	0.074	NS
G3	**G1**	20.28	0.022	S	20.74	0.015	S	19.72	0.054	NS	28.79	0.003	S	20.16	0.000	S	19.47	0.088	NS
	G2	10.34	0.285	NS	10.32	0.252	NS	9.75	0.452	NS	12.77	0.167	NS	11.42	0.012	S	9.58	0.544	NS
	G4	-10.30	0.288	NS	-9.89	0.281	NS	-10.85	0.369	NS	-13.18	0.150	NS	-8.03	0.067	NS	-10.75	0.456	NS
G4	**G1**	30.58	0.002	S	30.63	0.001	S	30.58	0.005	S	41.97	0.000	S	28.19	0.000	S	30.22	0.010	S
	G2	20.65	0.020	S	20.21	0.017	S	20.61	0.044	S	25.95	0.006	S	19.45	0.000	S	20.34	0.074	NS
	G3	10.30	0.288	NS	9.89	0.281	NS	10.85	0.369	NS	13.18	0.150	NS	8.03	0.067	NS	10.75	0.456	NS

Table 14 Tukey's test for Root Length(cm) T1-T6

For treatment 1 there is a significant difference between the groups G1(Open 2021) - G3(Open 2022), G1(Open 2021) – G4(Protected 2022), G3(Open 2022)-G1(Open 2021) and G4(Protected 2022)-G1(Open 2021) with significance value of 0.022, 0.002 and mean difference of -20.28, -30.28, 20.28, 30.28. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 2 there is a significant difference between the groups G1(Open 2021)-G3(Open2022) G1(Open 2021) – G4(Protected 2022) G3(Open 2022)- G1(Open 2021) and G4(Protected 2022)- G1(Open 2021) with significance value of 0.015, 0.001 and mean difference of -20.74, -30.63 and 30.63. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 3 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022) and G4(Protected 2022)-G1(Open 2021) with significance value of 0.005 and mean difference of -30.58 and 30.58. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 4 there is a significant difference between the groups G1(Open 2021) – G3 (Open 2022) G1(Open 2021) – G4(Protected 2022) G3(Open 2021) – G1(Open 2021) and G4(Protected 2022)-G1(Open 2021) with significance value of 0.003, 0.000 and mean difference of -28.79, -41.97, , 41.97. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 5 there is a significant difference between the groups G1(Open 2021) – G2(Protected 2021) G1 (Open 2021) - G3(Open 2022) G1(Open 2021)– G4(Protected 2022), G2(Protected 2022) – G1(Open 2021) G3(Open 2022) – G1(Open 2021) and G4(Protected 2022)-G1(Open 2021), with a significance value of 0.000, and mean difference of -8.73 ,-20.16, -28.19, -19.45, 8.73, 20.16, 28.19 and 19.45 and the remaining groups doesn't have mean significant difference.

For treatment 6, there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022) and G4(Protected 2022)-G1(Open 2021) with a significance value of 0.010, 0.010 and mean difference of -30.22, 30.22. On the other hand, the remaining groups doesn't have mean significant difference.

Groups		T7			T8			T9			T10			T11			T12		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-10.47	0.433	NS	-10.20	0.122	NS	-10.22	0.208	NS	-10.39	0.175	NS	-10.36	0.197	NS	-10.39	0.211	NS
	G3	-18.57	0.085	NS	-20.11	0.004	S	-21.10	0.009	S	-21.10	0.007	S	-16.63	0.030	S	-21.31	0.009	S
	G4	-29.56	0.009	S	-32.40	0.000	S	-33.89	0.000	S	-24.08	0.003	S	-22.12	0.006	S	-25.44	0.003	S
G2	**G1**	10.47	0.433	NS	10.20	0.122	NS	10.22	0.208	NS	10.39	0.175	NS	10.36	0.197	NS	10.39	0.211	NS
	G3	-8.09	0.626	NS	-9.91	0.135	NS	-10.88	0.172	NS	-10.70	0.160	NS	-6.26	0.564	NS	-10.92	0.182	NS
	G4	-19.08	0.076	NS	-22.20	0.002	S	-23.66	0.004	S	-13.68	0.063	NS	-11.76	0.130	NS	-15.05	0.054	NS
G3	**G1**	18.57	0.085	NS	20.11	0.004	S	21.10	0.009	S	21.10	0.007	S	16.63	0.030	S	21.31	0.009	S
	G2	8.09	0.626	NS	9.91	0.135	NS	10.88	0.172	NS	10.70	0.160	NS	6.26	0.564	NS	10.92	0.182	NS
	G4	-10.99	0.396	NS	-12.28	0.058	NS	-12.78	0.098	NS	-2.98	0.908	NS	-5.49	0.656	NS	-4.13	0.824	NS
G4	**G1**	29.56	0.009	S	32.40	0.000	S	33.89	0.000	S	24.08	0.003	S	22.12	0.006	S	25.44	0.003	S
	G2	19.08	0.076	NS	22.20	0.002	S	23.66	0.004	S	13.68	0.063	NS	11.76	0.130	NS	15.05	0.054	NS
	G3	10.99	0.396	NS	12.28	0.058	NS	12.78	0.098	NS	2.98	0.908	NS	5.49	0.656	NS	4.13	0.824	NS

Table 15 Tukey's test for Root Length(cm) T7-T12

For treatment 7 there is a significant difference between G1(Open 2021)- G4(Protected 2022), G4(Protected 2022) – G1(Open 2021) with significant values of 0.009 and 0.009 and mean difference -29.56,29.56, on the other hand, the remaining groups doesn't have a significant difference.

For treatment 8 there is a significant difference between G1(Open 2021) – G3(Open 2022) , G1(Open 2021) – G4(Protected 2022) , G2(Protected 2021) –G4(Protected 2022) , G3(Open 2022) – G1(Open 2021) , G4(Protected 2022) – G1(Open 2021) , G4(Protected 2022) – G2(Protected 2021) with the significant values of 0.040, 0.000 , 0.002 , 0.004 , 0.000 , 0.002 and mean difference -20.11,-32.40,-22.20,20.11,32.40,22.20, on the other hand, the remaining group doesn't have a significant difference

For treatment 9 there is a significant difference between G1(Open 2021) -G3(Protected 2022), G1(Open 2021)-G4(Protected 2022),

G2(Protected 2021)-G4(Protected 2022), G3(Open 2022)-G1(Open 2021), G4(Protected 2022)- G1(Open 2021), G4(Protected 2022)-G2(Protected 2021) with significant values 0.009,0.000,0.004, 0.009, 0.000, 0.004 and mean difference -21.10,-33.89,-23.66,21.10,33.89,23.66
on the other hand the remaining groups doesn't have significant difference

For treatment 10 there is a significant difference between G1(ope on the othe n 2021)-G3(Open 2022), G1(Open 2021)- G4(Protected 2022)

G3(Open 2022)- G1(Open 2021), G4(Protected 2022)- G1(Open 2021) with significant values 0.007, 0.003, 0.007, 0.003 and mean difference -21.10**,** -24.08,21.10,24.08 on the other hand the remaining groups doesn't have significant difference

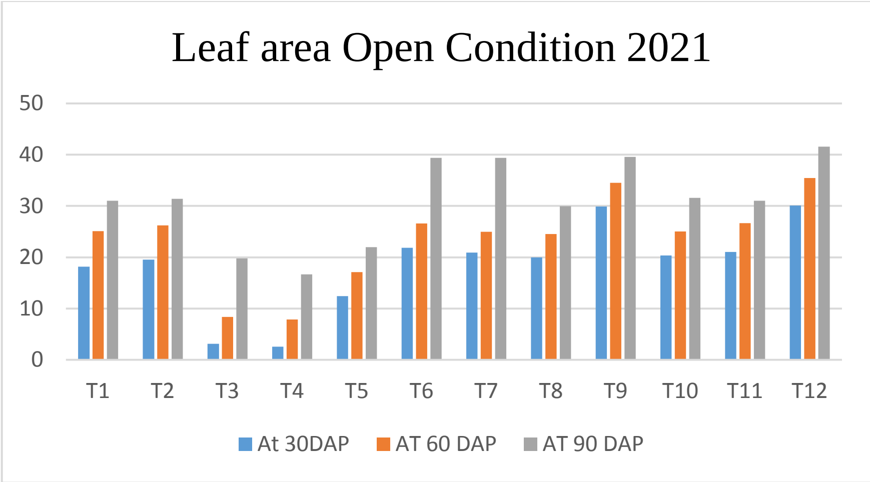
For treatment 11 there is a significant difference between G1(Open 2021)- G3(Open 2022), G1(Open 2021) – G4(Protected 2022)

G3(Open 2022)- G1(Open 2021), G4(Protected 2022)-G1(OPEN 2021) with significant values 0.030, 0.006, 0.030, 0.006 and the mean difference -16.63, -22.12, 16.63, 22.12 on the other hand, the remaining groups, doesn't have a significant difference

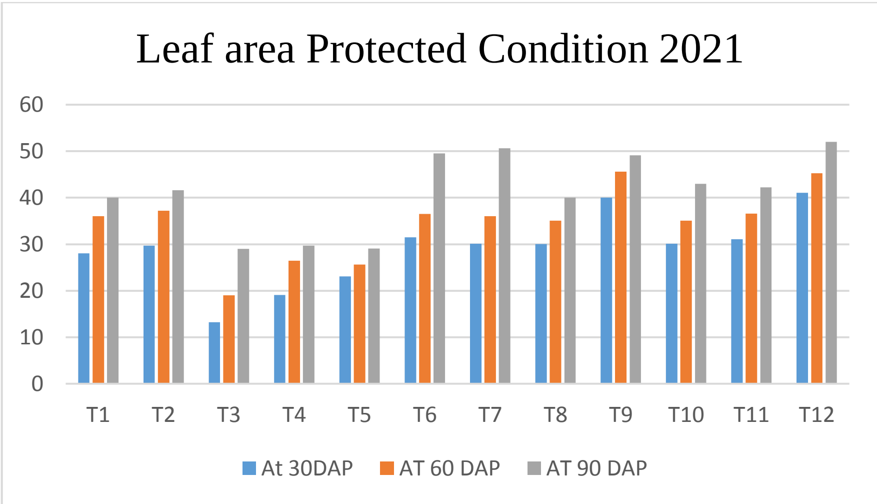
8.6: Impact of different growing media on Leaf Area in Guava cuttings (*Psidium guajava L.*):

Treatment Symbol	2021								2022							
	Leaf Area								Leaf Area							
	Open Conditions (cm^2)				Protected Conditions (cm^2)				Open Conditions (cm^2)				Protected Conditions (cm^2)			
	At 30 DAP	AT 60 DAP	AT 90 DAP	Mean	At 30 DAP	AT 60 DAP	AT 90 DAP	Mean	At 30 DAP	AT 60 DAP	AT 90 DAP	Mean	At 30 DAP	AT 60 DAP	AT 90 DAP	Mean
T1	17.16	25.31	31.31	24.59	37.17	46.12	51.15	44.81	24.15	36.31	41.15	33.87	47.66	56.15	62.31	55.37
T2	16.57	26.25	31.41	24.74	36.15	47.16	52.25	45.19	26.66	37.21	41.61	35.16	51.31	57.16	62.17	56.88
T3	26.63	34.51	38.56	33.23	52.51	56.31	62.24	57.02	41.20	45.30	51.70	46.07	55.21	56.25	67.66	59.71
T4	31.17	35.47	41.55	36.06	51.15	58.72	65.57	58.48	36.66	45.62	56.16	46.15	52.61	66.31	68.42	62.45
T5	12.45	17.31	22.31	17.36	36.31	45.16	57.67	46.38	23.16	33.66	36.15	30.99	42.31	56.14	67.67	55.37
T6	21.75	26.61	36.41	28.26	42.16	46.67	57.53	48.79	31.50	36.50	46.50	38.17	53.33	57.21	67.31	59.28
T7	21.63	27.31	36.11	28.35	41.41	49.66	61.67	50.91	31.60	36.30	51.70	39.87	46.31	46.67	57.14	50.04
T7	16.65	24.52	26.66	22.61	41.14	45.66	47.17	44.66	31.24	35.16	36.66	34.35	52.26	56.17	63.33	57.25
T6	12.56	17.74	26.66	18.99	31.14	36.76	46.64	38.18	16.15	26.45	36.66	26.42	31.14	36.76	46.64	38.18
T31	21.33	25.15	33.57	26.68	41.65	45.65	53.66	46.99	31.31	35.16	42.66	36.38	47.16	51.31	52.14	50.20
T31	21.15	26.66	31.15	26.32	36.66	43.67	47.31	42.55	36.15	38.56	42.25	38.99	42.31	47.77	55.16	48.41
T12	13.12	17.37	26.72	19.07	24.52	27.17	37.61	29.77	13.24	16.31	27.67	19.07	35.16	36.24	47.66	39.69
Mean	19.35	25.35	31.87	25.52	39.33	45.73	53.37	46.14	28.59	35.21	42.57	35.46	46.40	52.01	59.80	52.74
CD at 5%	3.64	3.73	3.85	3.74	5.60	6.31	5.59	5.74	5.59	5.86	5.70	5.41	4.81	6.01	4.36	4.85

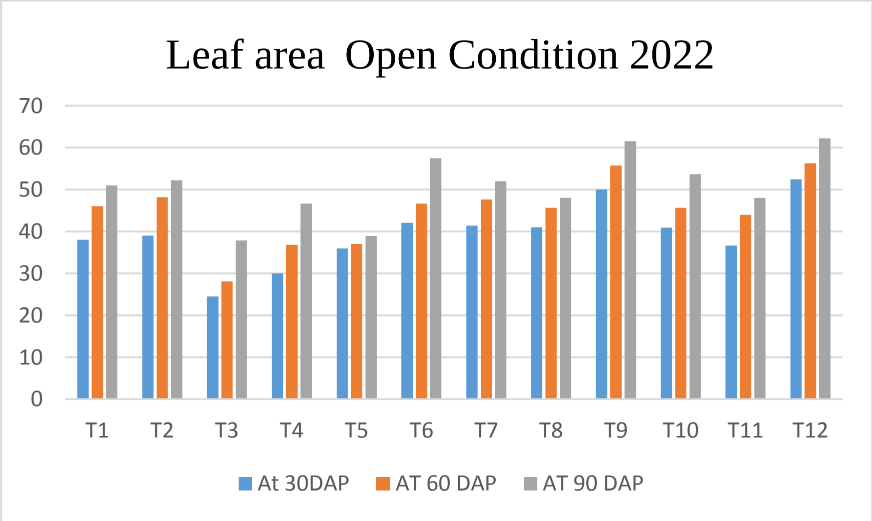
Table 16 Leaf Area (cm^2)



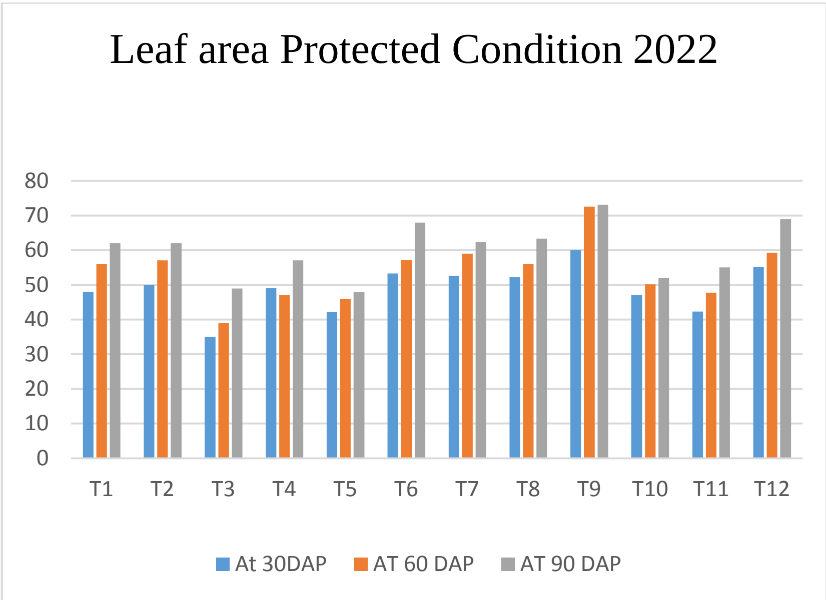
Graph 17 Leaf Area Open Condition 2021



Graph 18 Leaf Area Protected Condition 2021



Graph 19 Leaf Area Open Condition 2022



Graph 20 Leaf Area Protected Condition 2022

Tukey's test for Leaf Area

Groups		T1			T2			T3			T4			T5			T6		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G3**	-8.83	0.315	NS	-10.43	0.348	NS	-8.87	0.435	NS	-18.03	0.073	NS	-8.73	0.048	S	-8.88	0.531	NS
	G3	-30.38	0.033	S	-30.74	0.015	S	-18.73	0.054	NS	-38.78	0.003	S	-30.18	0.000	S	-18.47	0.088	NS
	G4	-30.38	0.003	S	-30.83	0.001	S	-30.58	0.005	S	-41.87	0.000	S	-38.18	0.000	S	-30.33	0.010	S
G3	**G1**	8.83	0.315	NS	10.43	0.348	NS	8.87	0.435	NS	18.03	0.073	NS	8.73	0.048	S	8.88	0.531	NS
	G3	-10.34	0.385	NS	-10.33	0.353	NS	-8.75	0.453	NS	-13.77	0.187	NS	-11.43	0.013	S	-8.58	0.544	NS
	G4	-30.85	0.030	S	-30.31	0.017	S	-30.81	0.044	S	-35.85	0.008	S	-18.45	0.000	S	-30.34	0.074	NS
G3	**G1**	30.38	0.033	S	30.74	0.015	S	18.73	0.054	NS	38.78	0.003	S	30.18	0.000	S	18.47	0.088	NS
	G3	10.34	0.385	NS	10.33	0.353	NS	8.75	0.453	NS	13.77	0.187	NS	11.43	0.013	S	8.58	0.544	NS
	G4	-10.30	0.388	NS	-8.88	0.381	NS	-10.85	0.388	NS	-13.18	0.150	NS	-8.03	0.087	NS	-10.75	0.458	NS
G4	**G1**	30.58	0.003	S	30.83	0.001	S	30.58	0.005	S	41.87	0.000	S	38.18	0.000	S	30.33	0.010	S
	G3	30.85	0.030	S	30.31	0.017	S	30.81	0.044	S	35.85	0.008	S	18.45	0.000	S	30.34	0.074	NS
	G3	10.30	0.388	NS	8.88	0.381	NS	10.85	0.388	NS	13.18	0.150	NS	8.03	0.087	NS	10.75	0.458	NS

Table 17 Tukey's test for Leaf Area T1-T6

For treatment 1 there is a significant difference between the groups G1(Open 2021) - G3(Open 2022), G1(Open 2021) – G4(Protected 2022), G3(Open 2022)-G1(Open 2021) and G4(Protected 2022)-G1(Open 2021) with significance value of 0.022, 0.002 and mean difference of -20.28, -30.28, 20.28, 30.28. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 2 there is a significant difference between the groups G1(Open 2021)-G3(Open2022) G1(Open 2021) – G4(Protected 2022) G3(Open 2022)- G1(Open 2021) and G4(Protected 2022)- G1(Open 2021) with significance value of 0.015, 0.001 and mean difference of -20.74, -30.63 and 30.63. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 3 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022) and G4(Protected 2022)-G1(Open 2021) with significance value of 0.005 and mean difference of -30.58 and 30.58. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 4 there is a significant difference between the groups G1(Open 2021) – G3 (Open 2022) G1(Open 2021) – G4(Protected 2022) G3(Open 2021) – G1(Open 2021) and G4(Protected 2022)-G1(Open 2021) with significance value of 0.003, 0.000 and mean difference of -28.79, -41.97, , 41.97. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 5 there is a significant difference between the groups G1(Open 2021) – G2(Protected 2021) G1 (Open 2021) - G3(Open 2022) G1(Open 2021)– G4(Protected 2022), G2(Protected 2022) – G1(Open 2021) G3(Open 2022) – G1(Open 2021) and G4(Protected 2022)-G1(Open 2021), with significance value of 0.000, and mean difference of -8.73, -20.16, -28.19, -19.45, 8.73, 20.16, 28.19 and 19.45 and the remaining groups doesn't have mean significant difference.

For treatment 6 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022) and G4(Protected 2022)-G1(Open 2021) with significance value of 0.010, 0.010 and mean difference of -30.22, 30.22. On the other hand, the remaining groups doesn't have mean significant difference.

Groups		T7			T8			T9			T10			T11			T12		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-10.42	0.422	NS	-10.20	0.122	NS	-10.22	0.208	NS	-10.29	0.125	NS	-10.26	0.192	NS	-10.29	0.211	NS
	G2	-18.52	0.085	NS	-20.11	0.004	S	-21.10	0.009	S	-21.10	0.002	S	-16.62	0.020	S	-21.21	0.009	S
	G4	-29.56	0.009	S	-22.40	0.000	S	-22.89	0.000	S	-24.08	0.002	S	-22.12	0.006	S	-25.44	0.002	S
G2	**G1**	10.42	0.422	NS	10.20	0.122	NS	10.22	0.208	NS	10.29	0.125	NS	10.26	0.192	NS	10.29	0.211	NS
	G2	-8.09	0.626	NS	-9.91	0.125	NS	-10.88	0.122	NS	-10.20	0.160	NS	-6.26	0.564	NS	-10.92	0.182	NS
	G4	-19.08	0.026	NS	-22.20	0.002	S	-22.66	0.004	S	-12.68	0.062	NS	-11.26	0.120	NS	-15.05	0.054	NS
G2	**G1**	18.52	0.085	NS	20.11	0.004	S	21.10	0.009	S	21.10	0.002	S	16.62	0.020	S	21.21	0.009	S
	G2	8.09	0.626	NS	9.91	0.125	NS	10.88	0.122	NS	10.20	0.160	NS	6.26	0.564	NS	10.92	0.182	NS
	G4	-10.99	0.296	NS	-12.28	0.058	NS	-12.28	0.098	NS	-2.98	0.908	NS	-5.49	0.656	NS	-4.12	0.824	NS
G4	**G1**	29.56	0.009	S	22.40	0.000	S	22.89	0.000	S	24.08	0.002	S	22.12	0.006	S	25.44	0.002	S
	G2	19.08	0.026	NS	22.20	0.002	S	22.66	0.004	S	12.68	0.062	NS	11.26	0.120	NS	15.05	0.054	NS
	G2	10.99	0.296	NS	12.28	0.058	NS	12.28	0.098	NS	2.98	0.908	NS	5.49	0.656	NS	4.12	0.824	NS

Table18 Tukey's test for Leaf Area T7-T12

For treatment 7 there is a significant difference between G1(Open 2021)- G4(Protected 2022), G4(Protected 2022) – G1(Open 2021) with the significant values of 0.009 and 0.009 and mean difference -29.56,29.56 on the other hand the remaining groups doesn’t have significant difference.

For treatment 8 there is a significant difference between G1(Open 2021) – G3(Open 2022) , G1(Open 2021) – G4(Protected 2022) , G2(Protected 2021) –G4(Protected 2022) , G3(Open 2022) – G1(Open 2021) , G4(Protected 2022) – G1(Open 2021) , G4(Protected 2022) – G2(Protected 2021) with the significant values of 0.040, 0.000 , 0.002 , 0.004 , 0.000 , 0.002 and mean difference -20.11,-32.40,-22.20,20.11,32.40,22.20 on the other hand the remaining group doesn’t have significant difference

For treatment 9 there is a significant difference between G1(Open 2021) -G3(Protected 2022), G1(Open 2021)-G4(Protected 2022),

G2(Protected 2021)-G4(Protected 2022), G3(Open 2022)-G1(Open 2021), G4(Protected 2022)- G1(Open 2021), G4(Protected 2022)-G2(Protected 2021) with significant values 0.009,0.000,0.004, 0.009, 0.000, 0.004 and mean difference -21.10,-33.89,-23.66,21.10,33.89,23.66
on the other hand the remaining groups doesn’t have significant difference

For treatment 10 there is a significant difference between G1(ope on the othe n 2021)-G3(Open 2022), G1(Open 2021)- G4(Protected 2022)

G3(Open 2022)- G1(Open 2021), G4(Protected 2022)- G1(Open 2021) with significant values 0.007, 0.003, 0.007, 0.003 and mean difference -21.10**,** -24.08,21.10,24.08 on the other hand the remaining groups doesn’t have significant difference

For treatment 11 there is a significant difference between G1(Open 2021)- G3(Open 2022), G1(Open 2021) – G4(Protected 2022)

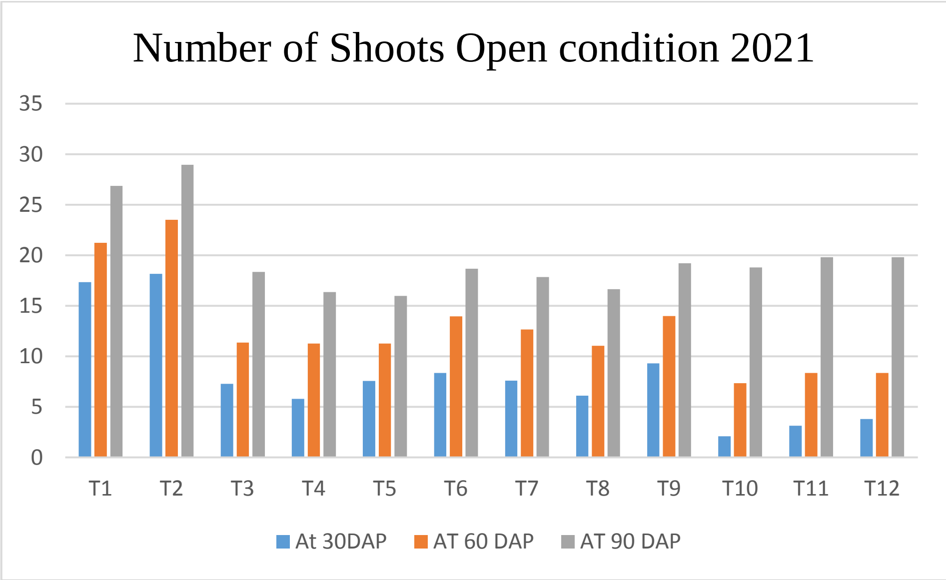
G3(Open 2022)- G1(Open 2021) , G4(Protected 2022)-G1(OPEN 2021) with significant values 0.030, 0.006, 0.030, 0.006 and the mean difference -16.63, -22.12, 16.63, 22.12 on the other hand, the remaining groups, doesn’t have significant difference

For treatment 12 there is a significant difference between G1(Open 2021)- G3(Open 2022), G1(Open 2021)- G4(Protected 2022) with the significant values 0.009, 0.030,0.009,0.030

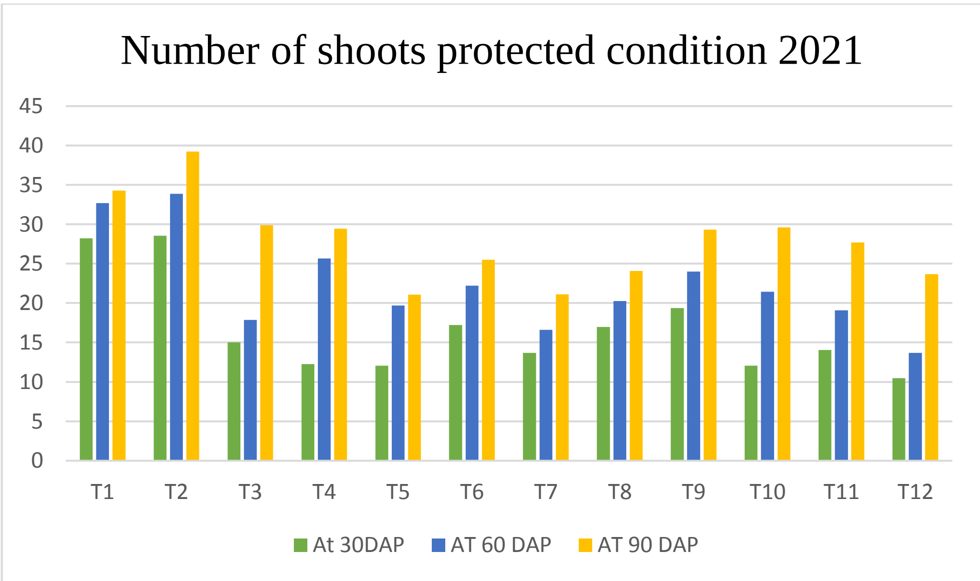
8.7: Impact of different growing media on Number of Shoots in Guava cuttings (*Psidium guajava* L.):

Treatment Symbol	2021								2022							
	Number of Shoots								Number of Shoots							
	Open Conditions				Protected Conditions				Open Conditions				Protected Conditions			
	At 30DAP	AT 60 DAP	AT 90 DAP	**Mean**	At 30DAP	AT 60 DAP	AT 90 DAP	**Mean**	At 30DAP	AT 60 DAP	AT 90 DAP	**Mean**	At 30DAP	AT 60 DAP	AT 90 DAP	**Mean**
T1	0.45	0.94	3.15	1.51	1.78	2.27	4.48	2.84	0.81	1.30	3.51	1.87	2.34	2.83	5.04	3.40
T2	0.60	1.09	3.30	1.66	1.93	2.42	4.63	2.99	0.96	1.45	3.66	2.02	2.49	2.98	5.19	3.55
T3	1.95	2.44	4.65	3.01	3.28	3.77	5.98	4.34	2.71	3.20	5.41	3.77	3.84	4.33	6.54	4.90
T4	0.95	1.44	3.65	2.01	3.68	4.17	6.38	4.74	1.31	1.80	4.01	2.37	2.84	3.33	5.54	3.90
T5	1.45	1.94	4.15	2.51	2.78	3.27	5.48	3.84	1.81	2.30	4.51	2.87	3.34	3.83	6.04	4.40
T6	2.55	3.04	5.25	3.61	3.88	4.37	6.58	4.94	2.91	3.40	5.61	3.97	4.44	4.93	7.14	5.50
T7	0.89	1.38	3.59	1.95	2.22	2.71	4.92	3.28	1.25	1.74	3.95	2.31	2.78	3.27	5.48	3.84
T8	0.58	1.07	3.28	1.64	1.91	2.40	4.61	2.97	0.94	1.43	3.64	2.00	2.47	2.96	5.17	3.53
T9	1.70	2.19	4.40	2.76	3.03	3.52	5.73	4.09	2.06	2.55	4.76	3.12	3.59	4.08	6.94	4.87
T10	1.30	1.79	4.00	2.36	2.63	3.12	5.33	3.69	1.66	2.15	4.36	2.72	3.19	3.68	5.89	4.25
T11	2.35	2.84	5.05	3.41	2.28	2.77	4.98	3.34	2.31	2.80	5.01	3.37	4.24	4.73	6.29	5.09
T12	1.60	2.09	4.30	2.66	2.93	3.42	5.63	3.99	1.96	2.45	4.66	3.02	3.49	3.98	6.19	4.55
Mean	1.36	1.85	4.06	2.43	2.69	3.18	5.39	3.76	1.72	2.21	4.42	2.79	3.25	3.74	5.95	4.32
CD at 5%	0.53	0.56	0.62	0.61	0.57	0.79	0.61	0.63	0.68	0.49	0.66	0.55	0.61	0.62	0.68	0.69

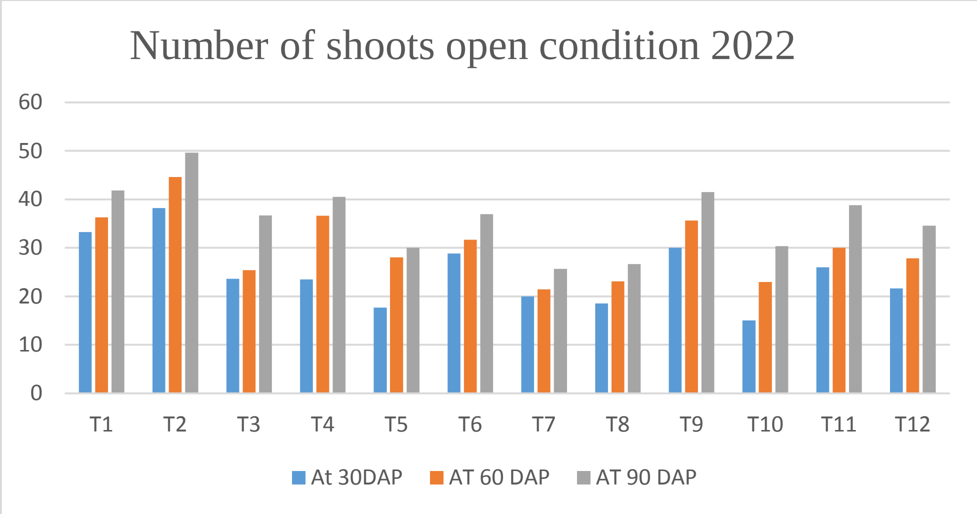
Table 19 Number of Shoots



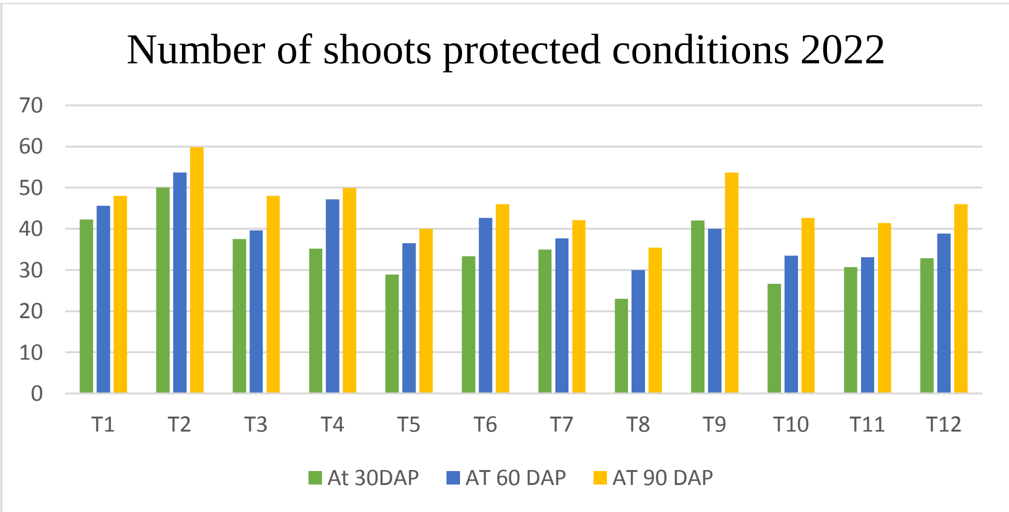
Graph 21 Number of Shoots Open Condition 2021



Graph 22 Number of Shoots Protected Condition 2021



Graph 23 Number of Shoots Open Condition 2022



Graph 24 Number of Shoots Protected Conditions 2022

Tukey's test for Number of Shoots:

Groups		T1			T2			T3			T4			T5			T6		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-9.91	0.055	NS	-10.33	0.162	NS	-8.57	0.434	NS	-11.31	0.362	NS	-6.00	0.557	NS	-7.98	0.293	NS
	G3	-15.32	0.006	S	-20.62	0.007	S	-16.25	0.065	NS	-22.43	0.035	S	-13.65	0.059	NS	-18.84	0.0098	S
	G4	-23.45	0.000	S	-30.95	0.000	S	-29.37	0.003	S	-32.97	0.004	S	-23.52	0.003	S	-27.02	0.001	S
G2	**G1**	9.91	0.055	NS	10.33	0.162	NS	8.57	0.434	NS	11.31	0.362	NS	6.00	0.557	NS	7.98	0.293	NS
	G3	-5.41	0.379	NS	-10.28	0.164	NS	-7.67	0.520	NS	-11.12	0.375	NS	-7.65	0.371	NS	-10.85	0.116	NS
	G4	-13.54	0.012	S	-20.62	0.007	S	-20.79	0.020	S	-21.66	0.041	S	-17.51	0.018	S	-19.03	0.008	S
G3	**G1**	15.32	0.006	S	20.62	0.007	S	16.25	0.065	NS	22.43	0.035	S	13.65	0.059	NS	18.84	0.008	S
	G2	5.41	0.379	NS	10.28	0.164	NS	7.67	0.520	NS	11.12	0.375	NS	7.65	0.371	NS	10.85	0.116	NS
	G4	-8.13	0.122	NS	-10.33	0.162	NS	-13.12	0.147	NS	-10.54	0.416	NS	-9.86	0.195	NS	-8.18	0.276	NS
G4	**G1**	23.45	0.000	S	30.95	0.000	S	29.37	0.003	S	32.97	0.004	S	23.52	0.003	S	27.02	0.001	S
	G2	13.54	0.012	S	20.62	0.007	S	20.79	0.020	S	21.66	0.041	S	17.51	0.018	S	19.03	0.276	S
	G3	8.13	0.122	NS	10.33	0.162	NS	13.12	0.147	NS	10.54	0.416	NS	9.86	0.195	NS	8.18	0.276	NS

Table 20 Tukey's test for Number of Shoots T1-T6

For treatment 1 there is a significant difference between the groups G1(Open 2021) - G3(Open 2022), G1(Open 2021) – G4(Protected 2022), G2(Protected 2021) – G4(Protected 2022), G3(Open 2022) - G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 202) - G2(Protected 2021) with significance values of 0.006, 0.000, 0.012 and mean difference of -15.32, -23.45, -13.54, 15.32, 23.45, 13.54. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 2 there is a significant difference between the groups G1(Open 2021) – G3(Open 2022), G1(Open 2021) – G4(Protected 2022), G2(Protected 2021) – G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022)-G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) with significance values of 0.007, 0.000 and mean difference of -20.62, -30.95, -20.62, 20.62, 30.95 and 20.62. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 3 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022), G2(Protected 2021) – G4(Protected 2022), G4(Protected 2022) – G1(Open 2021) and G4(Protected 2022)-G2(Protected 2021) with significance values of 0.003, 0.020 and mean difference of -29.37, -20.79, 29.37 and 20.79. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 4 there is a significant difference between the groups G1(Open 2021) – G3(Open 2022), G1(Open 2021) – G4(Protected 2022), G2(Protected 2021) – G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) with significance values of 0.035, 0.004, 0.041 and mean difference of -22.43, -32.97, -21.66, 22.43, 32.97, 21.66. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 6, there is a significant difference between the groups G1(Open 2021) – G3(Open 2022), G1(Open 2021) – G4(Protected 2022), G2(Protected 2021) – G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) with significance values of 0.009, 0.001, 0.008 and mean difference of -18.84, -27.02, -19.03, 18.84, 27.02 and 19.03 and the remaining groups doesn't have mean significant difference.

Groups		T7			T8			T9			T10			T11			T12		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-4.43	0.545	NS	-9.15	0.179	NS	-10.05	0.229	NS	-11.62	0.372	NS	-9.83	0.372	NS	-5.28	0.798	NS
	G3	-9.65	0.066	NS	-11.48	0.080	NS	-21.56	0.008	S	-13.37	0.270	NS	-21.17	0.024	S	-17.38	0.006	NS
	G4	-25.55	0.000	S	-18.20	0.008	S	-31.07	0.001	S	-24.85	0.025	S	-24.61	0.011	S	-28.59	0.005	S
G2	**G1**	4.43	0.545	NS	9.15	0.179	NS	10.56	0.229	NS	11.62	0.372	NS	9.83	0.372	NS	5.28	0.798	NS
	G3	-5.22	0.418	NS	-2.32	0.935	NS	-11.50	0.152	NS	-1.75	0.993	NS	-11.34	0.267	NS	-12.10	0.233	NS
	G4	-21.12	0.001	S	-9.04	0.186	NS	-21.01	0.010	S	-13.23	0.277	N S	-14.78	0.118	NS	-23.31	0.016	S
G3	**G1**	9.65	0.066	NS	11.48	0.080	NS	21.56	0.152	S	13.37	0.270	NS	21.17	0.024	S	17.38	0.066	NS
	G2	5.22	0.418	NS	2.32	0.935	NS	11.50	0.152	NS	1.75	0.993	NS	11.34	0.267	NS	12.10	0.233	NS
	G4	-15.89	0.005	S	-6.72	0.392	NS	-9.51	0.266	NS	-11.47	0.382	NS	-3.43	0.928	NS	-11.21	0.285	NS
G4	**G1**	25.55	0.000	S	18.20	0.008	S	31.07	0.001	S	24.85	0.025	S	24.61	0.011	S	28.59	0.005	S
	G2	21.12	0.001	S	9.04	0.186	NS	21.01	0.010	S	13.23	0.277	NS	14.78	0.118	NS	23.31	0.016	S
	G3	15.89	0.005	S	6.72	0.392	NS	9.51	0.266	NS	11.47	0.382	NS	3.43	0.928	NS	11.21	0.285	NS

Table 21 Tukey's test for Number of Shoots T7-T12

For treatment 7 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022), G2(Protected 2021) – G4(Protected 2022), G3(Open 2022) – G4(Protected 2022), G4(Protected 2022) - G1(Open 2021), G4(Protected 2022) – G2(Protected 2021) and G4(Protected 2022) – G3(Open 2022) with significance values of 0.000, 0.001, 0.005 and mean difference of -25.55, -21.12, -15.89, 25.55, 21.12, 15.89. On the other hand, the remaining groups doesn’t have mean significant difference.

For treatment 8 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significance values of 0.008 and mean difference of -18.20 and 18.20. On the other hand, the remaining groups doesn’t have mean significant difference.

For treatment 9 there is a significant difference between the groups G1(Open 2021) – G3(Open 2022), G1(Open 2021) – G4(Protected 2022), G2(Protected 2021) – G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) – G1(Open 2021) and G4(Protected 2022)-G2(Protected 2021) with significance values of 0.008, 0.001, 0.010, 0.152 and mean difference of -21.56, -37.07, -21.01, 21.56, 31.07 and 21.01 On the other hand, the remaining groups doesn’t have mean significant difference.

For treatment 10 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022), and G4(Protected 2022) - G1(Open 2021) with significance values of 0.025 and mean difference of -24.85, 24.85. On the other hand, the remaining groups doesn’t have mean significant difference.

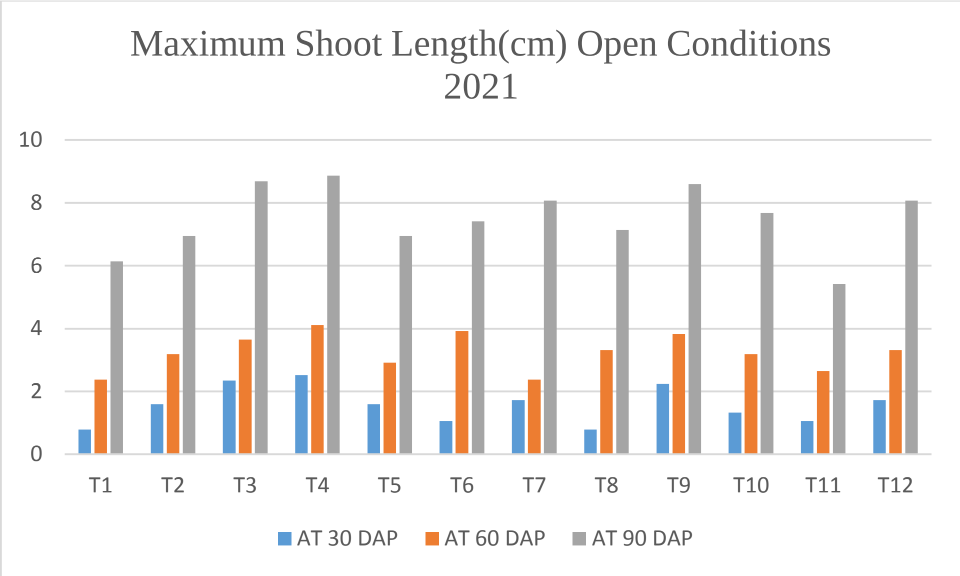
For treatment 11 there is a significant difference between the groups G1(Open 2021) – G3(Open 2022), G1(Open 2021) – G4(Protected 2022), G3(Open 2022) – G1(Open 2021) and G4(Protected 2022) - G1(Open 2021) with significance values of 0.024, 0.011 and mean difference of -21.17, -24.61, 21.17, 24.61. On the other hand, the remaining groups doesn’t have mean significant difference.

For treatment 12 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022), G2(Protected 2021) – G4(Protected 2022), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) with significance values of 0.005, 0.0016 and mean difference of -28.59, -23.31, 28.59 and 23.31 and the remaining groups doesn’t have mean significant difference.

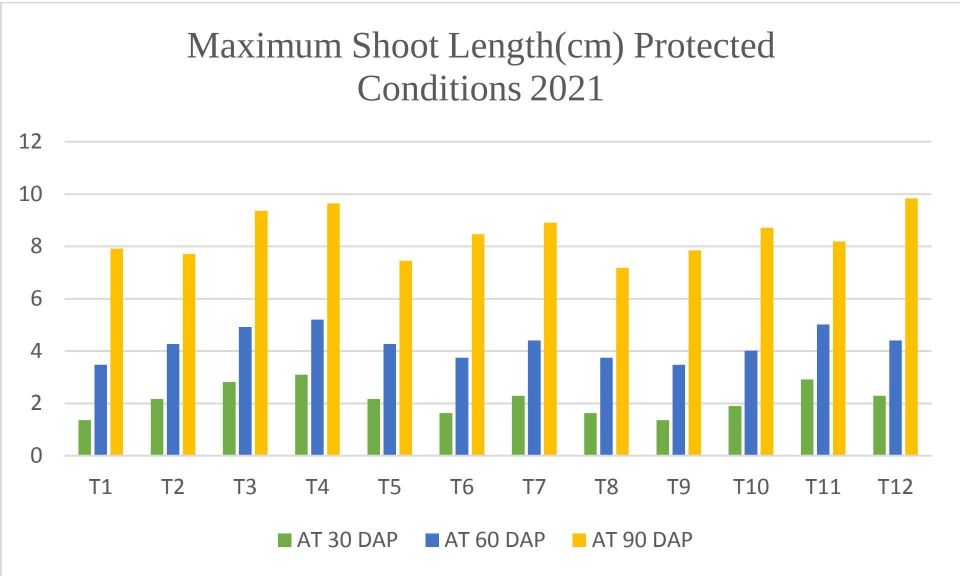
8.8: Impact of different growing media on Maximum Shoot Length(cm) in Guava cuttings (*Psidium guajava* L.):

Treatment Symbol	2021								2022							
	Maximum Shoot Length(cm)								Maximum Shoot Length(cm)							
	Open Conditions				Protected Conditions				Open Conditions				Protected Conditions			
	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean
T1	0.79	2.38	6.14	3.10	1.36	3.47	7.91	4.25	0.68	1.79	5.77	2.75	3.59	5.48	8.88	5.98
T2	1.59	3.18	6.94	3.90	2.16	4.27	7.71	4.71	1.48	2.59	6.57	3.55	2.52	4.41	8.81	5.25
T3	2.34	3.65	8.69	4.89	2.81	4.92	9.36	5.70	2.23	3.34	7.32	4.30	3.14	5.03	11.43	6.53
T4	2.52	4.11	8.87	5.17	3.09	5.20	9.64	5.98	2.41	3.52	7.50	4.48	3.04	4.93	13.23	7.07
T5	1.59	2.92	6.94	3.82	2.16	4.27	7.45	4.63	1.22	2.33	6.31	3.29	2.13	4.02	8.42	4.86
T6	1.06	3.93	7.41	4.13	1.63	3.74	8.46	4.61	0.95	2.06	6.04	3.02	2.39	4.28	8.68	5.12
T7	1.72	2.38	8.07	4.06	2.29	4.40	8.91	5.20	0.68	1.79	5.77	2.75	1.59	3.48	7.88	4.32
T8	0.79	3.31	7.14	3.75	1.63	3.74	7.18	4.18	1.61	2.72	6.70	3.68	3.32	5.21	7.61	5.38
T9	2.24	3.83	8.59	4.89	1.36	3.47	7.84	4.22	2.13	3.24	7.22	4.20	1.86	3.75	8.15	4.59
T10	1.33	3.18	7.68	4.06	1.90	4.01	8.71	4.87	1.48	2.59	6.57	3.55	2.39	4.28	11.67	6.11
T11	1.06	2.65	5.41	3.04	2.91	5.02	8.18	5.37	0.95	2.06	6.04	3.02	1.86	3.75	8.15	4.59
T12	1.72	3.31	8.07	4.37	2.29	4.40	9.84	5.51	1.61	2.72	6.70	3.68	2.52	4.41	8.81	5.25
Mean	1.56	3.24	7.50	4.10	2.13	4.24	8.43	4.94	1.45	2.56	6.54	3.52	2.53	4.42	9.31	5.42
CD at 5%	0.42	0.35	0.43	0.53	0.56	0.54	0.44	0.36	0.37	0.42	0.36	0.33	0.39	0.38	0.47	0.56

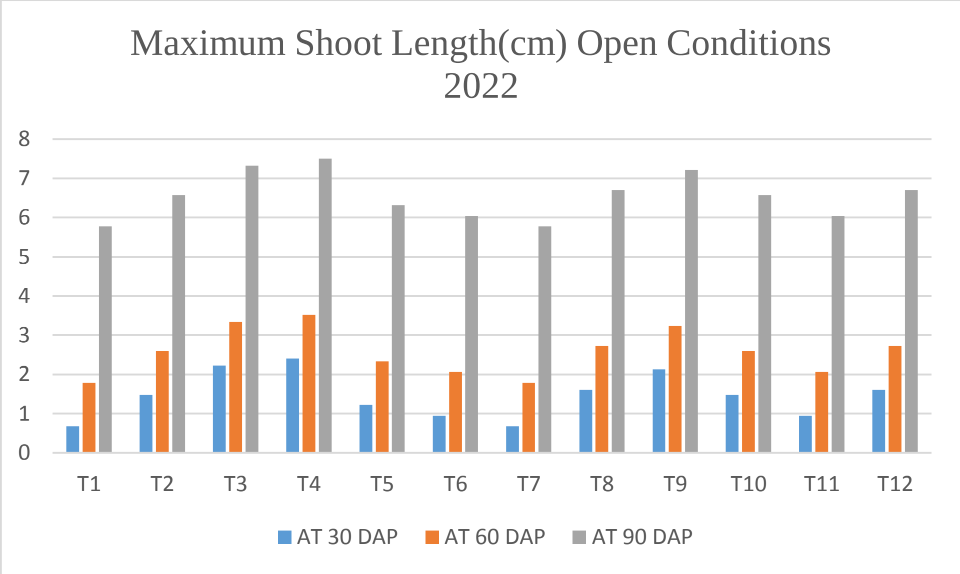
Table 22 Maximum Shoot Length(cm)



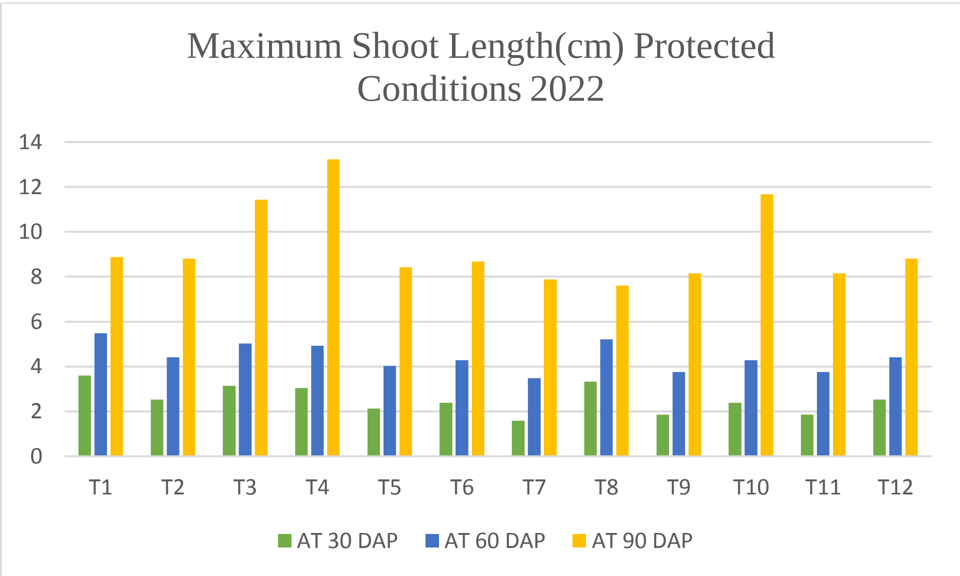
Graph 25 Maximum Shoot Length Open Condition 2021



Graph 26 Maximum Shoot Length Open Condition 2021



Graph 27 Maximum Shoot Length Open Condition 2022



Graph 28 Maximum Shoot Length Protected Condition 2022

Tukey's test for Maximum Shoot Length(cm):

Groups		T1			T2			T3			T4			T5			T6		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-11.05	0.374	NS	-9.84	0.526	NS	-11.38	0.330	NS	-4.18	0.842	NS	-11.48	0.091	NS	-12.01	0.126	NS
	G3	-21.29	0.043	S	-20.74	0.069	NS	-22.08	0.031	S	-15.64	0.060	NS	-22.19	0.003	S	-22.02	0.007	S
	G4	-26.83	0.013	S	-25.19	0.028	S	-32.84	0.003	S	-27.29	0.003	S	-26.95	0.001	S	-31.31	0.001	S
G2	**G1**	11.05	0.374	NS	9.84	0.526	NS	11.38	0.330	NS	4.18	0.842	NS	11.48	0.091	NS	12.01	0.126	NS
	G3	-10.24	0.433	NS	-10.90	0.447	NS	-10.70	0.377	NS	-11.45	0.188	NS	-10.71	0.119	NS	-10.01	0.225	NS
	G4	-15.77	0.143	NS	-15.35	0.202	NS	-21.46	0.036	S	-23.11	0.008	S	-15.47	0.024	S	-19.29	0.015	S
G3	**G1**	21.29	0.043	S	20.74	0.069	NS	22.08	0.031	S	15.64	0.060	NS	22.19	0.003	S	22.02	0.007	S
	G2	10.24	0.433	NS	10.90	0.447	NS	10.70	0.377	NS	11.45	0.188	NS	10.71	0.119	NS	10.01	0.225	NS
	G4	-5.53	0.824	NS	-4.44	0.917	NS	-10.76	0.372	NS	-11.65	0.179	NS	-4.76	0.671	NS	-9.28	0.275	NS
G4	**G1**	26.83	0.813	S	25.19	0.028	S	32.84	0.003	S	27.29	0.003	S	26.95	0.001	S	31.31	0.001	S
	G2	15.77	0.143	NS	15.35	0.202	NS	21.46	0.036	S	23.11	0.008	S	15.47	0.024	S	19.29	0.015	S
	G3	5.53	0.824	NS	4.44	0.917	NS	10.76	0.372	NS	11.65	0.179	NS	4.76	0.671	NS	9.28	0.275	NS

Table 23 Tukey's test for Maximum Shoot Length(cm) T1-T6

For treatment 1 there is a significant difference between G1(Open 2021) – G3(Open 2022) , G1(Open 2021) – G4(Protected 2022) ,G3(Open 2022) - G1(Open 2021) , G4(Protected 2022) - G1(Open 2021) with the significant values of 0.043, 0.013,0.043,0.813 and mean difference-21.29, -26.83, 21.29,26.83 on the other hand the remaining groups doesn't have significant difference

For treatment 2 there is a significant difference between G1(Open 2021) - G4(Protected 2022) ,and G4(Protected 2022) - G1(Open 2021) with the significant values of 0.028 , 0.028 and the mean difference -25.19,25.19 on the other hand the remaining groups doesn't have significant difference

For treatment 3 there is a significant difference between G1(Open 2021) – G3(Open 2022) ,G1(Open 2021) – G4(Protected 2022) , G2(Protected -2021) - G4(Protected 2022) , G3(Open 2022) - G1(Open 2021) , G4(Protected) – G1(Open 2021) , G4(Protected 2022) – G2(Protected 2021) with the significant values of 0.031, 0.003, 0.036, 0.031 ,0.003 ,0.036 and mean difference -22.08,-32..84, -21.46, 22.08, 32.84, 21.46 on the other hand the remaining groups doesn't have significant difference

For treatment 4 there is a significant difference between G1(Open 2021) – G4(Protected 2022) , G2(Protected 2021) - G4(Protected 2022), G4(Protected 2022) – G1(Open 2021) , G4(Protected 2022) – G2(Protected 2021) with the significant values of 0.003, 0.008, 0.003, 0.008 with mean difference -27.29,-23.11,27.29,23.11 on the other hand the remaining groups doesn't have significant difference

For treatment 5 there is a significant difference between G1(Open 2021) - G3(Open 2022) , G1(Open 2021) – G4(Protected 2022) , G2(Protected 2021) – G4(Protected 2022) , G3(Open 2022) – G1(Open 2021) ,G4(Protected 2022) – G1(Open 2021) , G4(Protected 2021)with the significant values of 0.003, 0.001, 0.024, 0.003, 0.001, 0.024 and mean difference -22.19, -26.95, -15.47, 22.19, 26.95, 15.47 on the other hand the remaining groups doesn't have significant difference

Groups		T7			T8			T9			T10			T11			T12		
		M.D	P-value	Status	M.D	P-Value	Status	M.D	P-Value	Status	M.D	P-Value	Status	M.D	P-Value	Status	M.D	P-Value	Status
G1	G2	-4.79	0.829	NS	-9.64	0.439	NS	-10.28	0.369	NS	-10.34	0.160	NS	-10.61	0.415	NS	-10.27	0.412	NS
	G3	-15.81	0.087	NS	-21.73	0.030	S	-16.20	0.097	NS	-16.16	0.025	S	-20.94	0.049	S	-13.94	0.196	NS
	G4	-20.93	0.024	S	-27.28	0.009	S	-31.36	0.003	S	-27.43	0.001	S	-28.13	0.011	S	-24.55	0.019	S
G2	G1	4.79	0.829	NS	9.64	0.439	NS	10.28	0.369	NS	10.34	0.160	NS	10.61	0.415	NS	10.27	0.412	NS
	G3	-11.02	0.278	NS	-12.08	0.270	NS	-5.92	0.755	NS	-5.82	0.568	NS	-10.32	0.436	NS	-3.67	0.933	NS
	G4	-16.14	0.080	NS	-17.64	0.077	NS	-21.08	0.031	S	-17.09	0.018	S	-17.51	0.103	NS	-14.28	0.182	NS
G3	G1	15.81	0.087	NS	21.73	0.030	S	16.20	0.097	NS	16.16	0.025	S	20.94	0.049	S	13.94	0.196	NS
	G2	11.02	0.278	NS	12.08	0.270	NS	5.92	0.755	NS	5.82	0.568	NS	10.32	0.436	NS	3.67	0.933	NS
	G4	-5.11	0.801	NS	-5.55	0.800	NS	-15.16	0.125	NS	-11.27	0.119	NS	-7.18	0.697	NS	-10.61	0.386	NS
G4	G1	20.93	0.024	S	27.28	0.009	S	31.36	0.003	S	27.43	0.001	S	28.13	0.011	S	24.55	0.019	S
	G2	16.14	0.080	NS	17.64	0.077	NS	21.08	0.031	S	17.09	0.018	S	17.51	0.103	NS	14.28	0.182	NS
	G3	5.11	0.801	NS	5.55	0.800	NS	15.16	0.125	NS	11.27	0.119	NS	7.18	0.697	NS	10.61	0.386	NS

Table 24 Tukey's test for Maximum Shoot Length(cm) T7-T12

For treatment 7 there is a significant difference between G1(Open 2021) –G4(Protected 2022), G4(Protected 2022) – G1(Open 2021) with the significant values of 0.024, 0.024 and mean difference -20.93,20.93 on the other hand the remaining groups doesn't have significant difference

For treatment 8 there is a significant difference between G1(Open 2021) – G3(Open 2022). G1(Open 2021) - G4(Protected 2022). G3(Open 2022) – G1(Open 2021). G4(Protected 2022) - G1(Open 2021) with the significant values of 0.0 30 ,0.009, 0.030. 0.009 and mean difference -21.73, -27.28,21.73,27.28 on the other hand the remaining groups doesn't have significant difference.

For treatment 9 there is a significant difference between G1(Open 2021) – G3(Open 2022), G2(Protected 2021) – G4(Protected 2022), G4(Protected 2022) – G1(Open 2021) with the significant values of 0.003, 0.031, 0.003, 0.031 and mean difference -31.36, -21.08, 31.36, 21.08 on the other hand the remaining groups doesn't have significant difference.

For treatment 10 there is a significant difference between G1(Open 2021) – G3(Open 2022), G1(Open 2021) – G4(Protected 2022). G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021). G4(Protected 2022) - G1(Open 2021), G4(Protected 2022) – G2(property 2021) with the significant values of 0.025 ,0.001, 0.018, 0.025, 0.001, 0.018 and mean difference -16.16, -27.43, -17.09,16.16,27.43,17.09 on the other hand the remaining groups doesn't have significant difference.

For treatment 11 there is a significant difference between G1(Open 2021) – G3(Open 2022), G1(Open 2021) – G4(Protected 2022), G3(Open 2022) – G1(Open 2021) . G4(Protected 2022) – G1(Open 2021), with the significant values 0.049, 0.011, 0.049, 0.011 and mean difference -20.94, -28.13, 20.94,28.13on the other hand the remaining groups doesn't have significant difference.

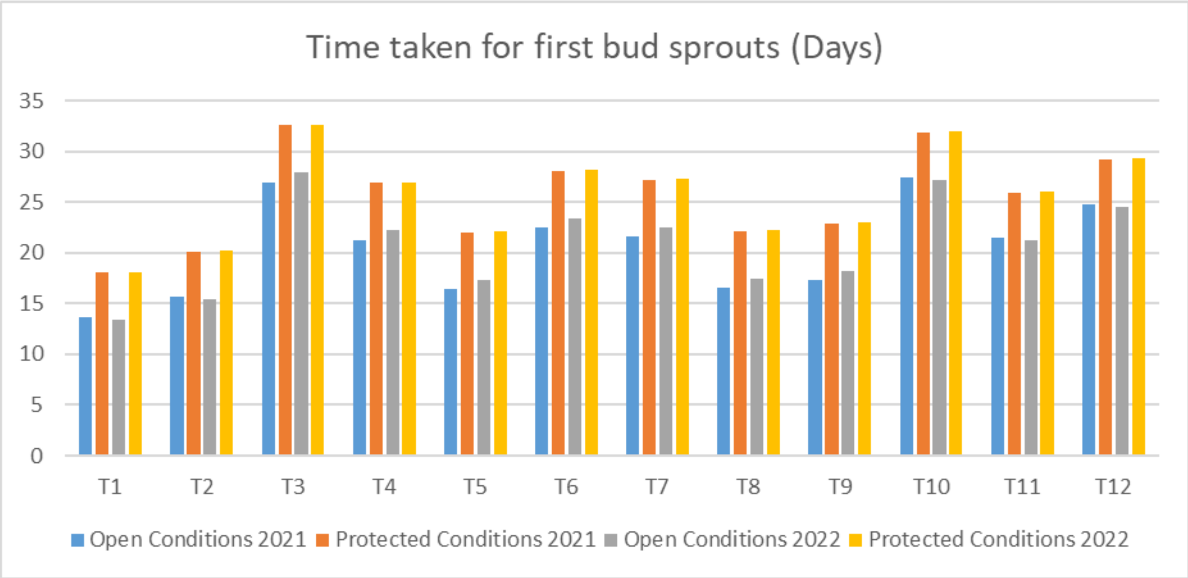
For treatment 12 there is a significant difference between G1(Open 2021) – G4(Protected 2022), and G4 (Protected 2022) – G1(Open 2021) with these the significant values 0.019 and 0.019 and mean difference -24.55, 24.55 on the other hand the remaining groups doesn't have significant difference.

8.9: Impact of different growing media on time taken for first bud sprout in Guava cuttings (*Psidium guajava* L.):

Treatment Symbol	2021		2022	
	Time taken for first bud sprouts (Days)		Time taken for first bud sprouts (Days)	
	Open Conditions	Protected Conditions	Open Conditions	Protected Conditions
T1	28.05	23.38	28.16	22.46
T2	22.86	18.19	22.97	17.27
T3	32.57	27.9	32.68	26.98
T4	26.88	22.21	26.99	21.29
T5	22.01	17.34	22.12	16.42
T6	18.03	13.36	18.14	13.61
T7	27.19	22.52	27.3	21.6
T8	22.12	17.45	22.23	16.53
T9	20.1	15.43	20.21	15.68
T10	31.9	27.23	32.01	27.48
T11	25.9	21.23	26.01	21.48
T12	29.25	24.58	29.36	24.83
CD AT 5 %	2.91	3.11	2.34	2.77

Table 25 Time taken for first bud sprouts

The table displays the first bud sprouts for 2021 and 2022. The critical difference (CD) is shown as well, which is the smallest statistically significant difference between two means at a 95% confidence level. The table illustrates that the time required for the first bud to emerge varies with pH, IBA concentration, and environmental conditions. The protected conditions require more time than the open conditions. The duration also increases at lower pH and IBA concentrations. The critical difference demonstrates that statistically significant differences exist between the means of certain treatments. In 2021 and 2022, for instance, the difference between the norms for T1 (pH 4.5) and T12 (Cutting in typical field soil with 0ppm IBA) is statistically significant. This table provides information beneficial for comprehending the factors that influence the time required for the first bud sprout to develop.

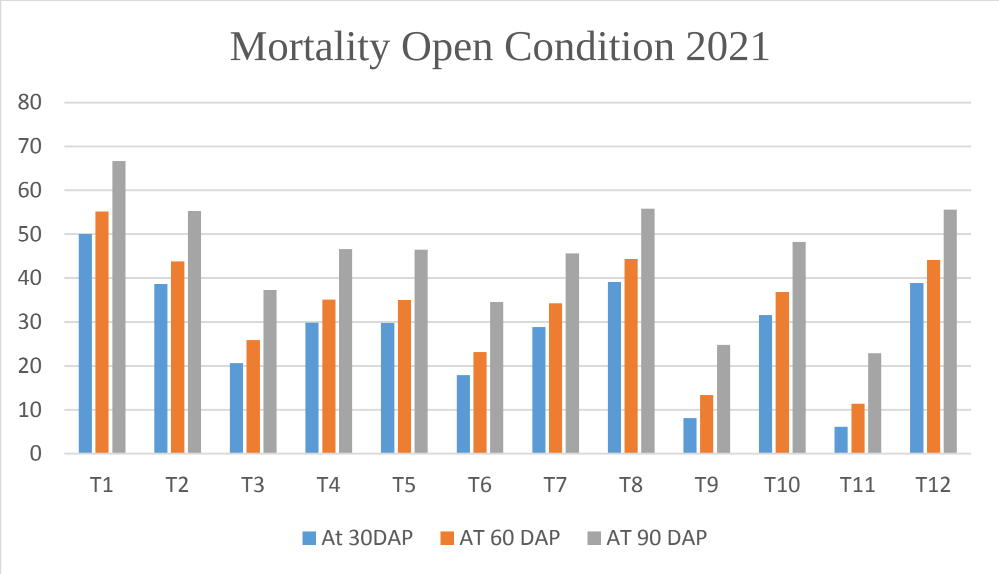


Graph 29 Time taken for first bud sprouts

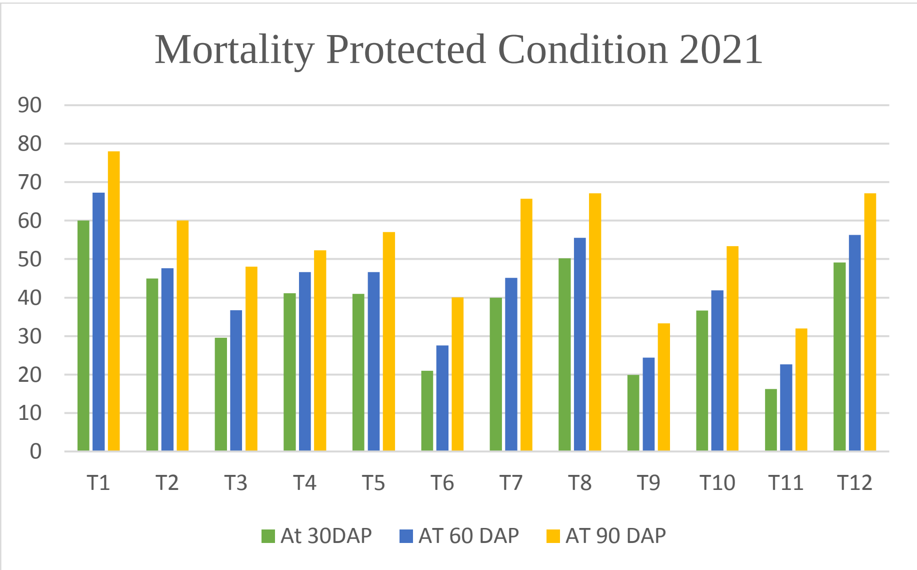
8.10: Impact of different growing media on Mortality of Cutting in Guava cuttings (*Psidium guajava* L.):

Treatment Symbol	2021								2022							
	Mortality								Mortality							
	Open Conditions				Protected Conditions				Open Conditions				Protected Conditions			
	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean
T1	58.52	64.02	72.57	65.04	45.51	51.01	54.56	50.36	52.70	58.20	66.75	59.22	45.75	51.25	59.80	52.27
T2	56.74	62.24	70.79	63.26	37.75	43.25	51.80	44.27	56.70	62.20	70.75	63.22	51.75	57.25	65.80	58.27
T3	53.75	59.25	67.80	60.27	41.48	46.98	55.53	48.00	50.75	56.25	64.80	57.27	49.99	55.49	56.04	53.84
T4	48.86	54.36	62.91	55.38	40.48	40.52	49.07	43.36	40.99	46.49	55.04	47.51	31.70	37.20	45.75	38.22
T5	57.76	63.26	71.81	64.28	47.58	53.08	61.63	54.10	70.29	75.79	84.34	76.81	31.20	46.70	55.25	44.38
T6	49.96	55.46	64.01	56.48	38.71	44.21	52.76	45.23	46.78	52.28	60.83	53.30	32.75	38.25	44.80	38.60
T7	55.73	61.23	69.78	62.25	42.68	48.18	56.73	49.20	61.75	67.25	75.80	68.27	34.49	39.99	48.54	41.01
T8	52.75	58.25	66.80	59.27	35.02	45.98	54.53	45.18	56.75	62.25	70.80	63.27	47.92	53.42	61.97	54.44
T9	37.52	43.02	51.57	44.04	24.85	30.35	38.90	31.37	39.96	45.46	54.01	46.48	25.71	31.21	39.76	32.23
T10	53.47	58.97	67.52	59.99	42.05	47.55	56.10	48.57	67.00	72.50	81.05	73.52	54.50	60.34	68.55	61.13
T11	46.18	51.68	60.23	52.70	45.48	50.98	59.53	52.00	64.38	69.88	78.43	70.90	41.79	43.29	45.84	43.64
T12	52.72	58.22	66.77	59.24	40.78	46.28	54.83	47.30	57.60	63.10	71.65	64.12	46.68	52.18	60.73	53.20
Mean	52.00	57.50	66.05	58.51	40.20	45.70	53.83	46.58	55.47	60.97	69.52	61.99	41.19	47.21	54.40	47.60
CD at 5%	**5.33**	**4.89**	**5.32**	**6.34**	**5.68**	**6.12**	**8.28**	**9.21**	**8.67**	**9.45**	**8.45**	**9.39**	**5.33**	**4.89**	**5.32**	**6.34**

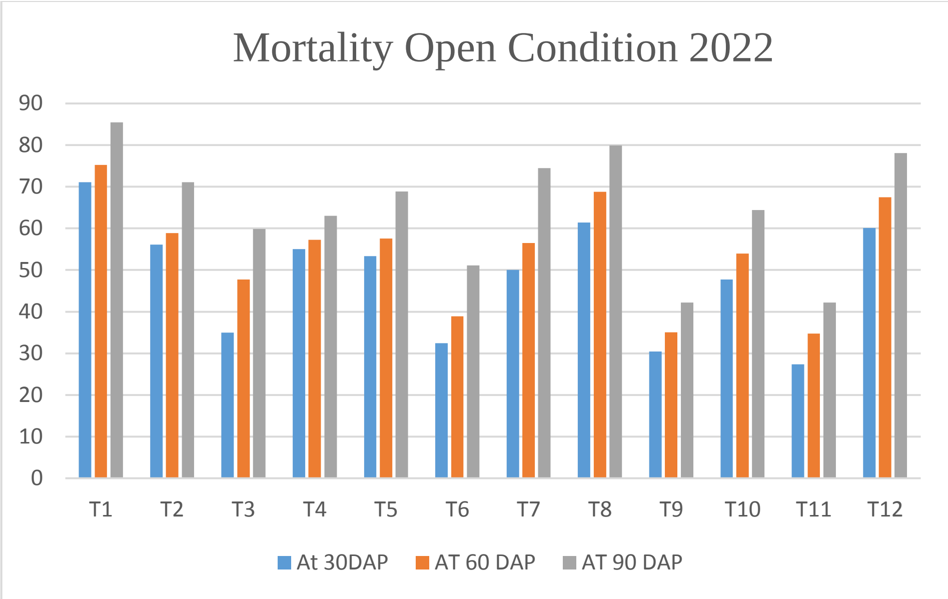
Table 26 Mortality



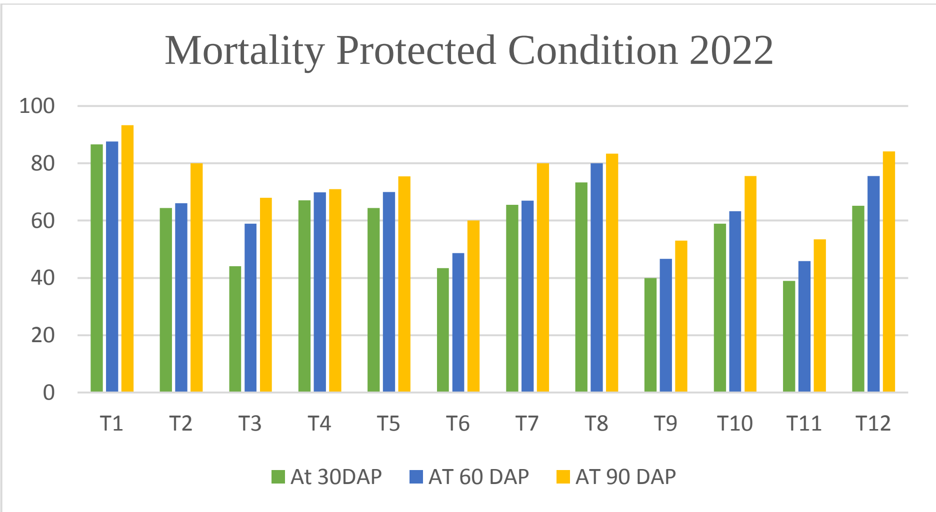
Graph 30 Mortality Open Condition 2021



Graph 31 Mortality Protected Condition 2021



Graph 32 Mortality Open Condition 2022



Graph 33 Mortality Protected Condition 2022

Tukey's test for Mortality:

Groups		T1			T2			T3			T4			T5			T6		
		M.D	P-value	Status	M.D	P-Value	Status	M.D	P-Value	Status	M.D	P-Value	Status	M.D	P-Value	Status	M.D	P-Value	Status
G1	G2	-11.14	0.329	NS	-4.99	0.879	NS	-10.18	0.665	NS	-9.47	0.239	NS	-11.11	0.348	NS	-4.34	0.933	NS
	G3	-19.98	0.045	S	-16.10	0.158	NS	-19.62	0.192	NS	-21.24	0.007	S	-22.81	0.027	S	-15.60	0.229	NS
	G4	-31.90	0.003	S	-24.26	0.029	S	-29.05	0.043	S	-32.13	0.000	S	-32.82	0.003	S	-25.53	0.035	S
G2	G1	11.14	0.329	NS	4.99	0.879	NS	10.18	0.665	NS	9.47	0.239	NS	11.11	0.348	NS	4.34	0.933	NS
	G3	-8.84	0.506	NS	-11.11	0.408	NS	-9.43	0.712	NS	-11.77	0.121	NS	-11.69	0.311	NS	-11.26	0.468	NS
	G4	-20.76	0.038	S	-19.27	0.082	NS	-18.86	0.216	NS	-22.65	0.005	S	-21.70	0.034	S	-21.19	0.080	NS
G3	G1	19.98	0.045	S	16.10	0.158	NS	19.62	0.192	NS	21.24	0.007	S	22.81	0.027	S	15.60	0.229	NS
	G2	8.84	0.506	NS	11.11	0.408	NS	9.43	0.712	NS	22.77	0.121	NS	11.69	0.311	NS	11.26	0.468	NS
	G4	-11.92	0.280	NS	-8.15	0.640	NS	-9.43	0.712	NS	-10.88	0.158	NS	-10.01	0.429	NS	-9.93	0.564	NS
G4	G1	31.90	0.003	S	24.26	0.029	S	29.05	0.043	S	32.13	0.000	S	32.82	0.003	S	25.53	0.035	S
	G2	20.76	0.038	S	19.27	0.082	NS	18.86	0.216	NS	22.65	0.005	S	21.70	0.034	S	21.19	0.080	NS
	G3	11.92	0.280	NS	8.15	0.640	NS	9.43	0.712	NS	10.88	0.158	NS	10.01	0.429	NS	9.93	0.564	NS

Table 27 Tukey's test for Mortality T1-T6

For treatment 1 there is a significant difference between G1(Open 2021)- G3(Open 2022), G1(Open 2021)- G4(Protected 2022), G2(Protected 2021)- G4(Protected 2022) , G3(Open 2022) – G1(Open 2021) , G4(Protected 2022) –G1(Open 2021), G4(Protected 2022)- G2(Protected 2022)with significant values 0.045, 0.003,0.038,0.045,0.003,0.038,0.280with mean difference -19.98, -31.90, -20.76,19..98,31.90,20.76 on the other hand the remaining group doesn’t have significant difference

For treatment 2 there is a significant difference between G1(Open 2021)- G4(Protected 2022) ,G4(Protected 2022)- G1(Open 2021)With significant values 0.029 ,0.029 with mean difference -24.26, 24.26, on the other hand the remaining group doesn’t have significant difference

For treatment 3 there is a significant difference between G1(Open 2021)- G4(Protected 2022), G4(Protected 2022)-G1(Open 2021) With significant values 0.043 ,0.043, and mean difference -29.05,29.05 on the other hand the remaining group doesn’t have significant difference

For treatment 4 there is a significant difference between G1(Open 2021)- G3(Open 2022), G1(Open 2021) – G4(Protected 2022), G2(Protected 2021)-G4(Protected 2022) , G3(Open 2022)-G1(Open 2021), G4(Protected 2022)-G1(Open 2021), G4(Protected 2022)- G2(Protected 2021) with significant values 0.007, 0.000, 0.005, 0.007, 0.000, 0.005 with mean difference -21.24, -31.13, -22.65, 21.24, 32.13, 22.65 on the other hand the remaining group doesn’t have significant difference

For treatment 5 there is a significant difference between G1(Open 2021)-G3(Open 2022), G1(Open 2021)- G4(Protected 2022). G2(Protected 2021)- G4(Protected 2022), G3(Open 2022)-G1(Open 2021), G4(Protected 2022)- G1(Open 2021), G4(Protected 2022)- G2(Protected 2021) with significant values 0.027, 0.0030.034, 0.027, 0.003,0.034 with mean difference -22.81, -32.82, -21.70, 22.81, 32.82, 21.70 on the other hand the remaining group doesn’t have significant difference

For treatment 6 there is a significant difference between G1(Open 2021)- G4(Protected 2022), G4(Protected 2022)-G1(Open 2021) with significant values 0.035, 0.035 with mean difference -25.53and 25.53 on the other hand the remaining group doesn’t have significant difference.

Groups		T7			T8			T9			T10			T11			T12		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-13.96	0.450	NS	-11.19	0.383	NS	-10.42	0.332	NS	-5.06	0.884	NS	-10.14	0.432	NS	-11.43	0.449	NS
	G3	-24.04	0.104	NS	-23.60	0.029	S	-20.46	0.030	S	-16.49	0.162	NS	-21.31	0.041	S	-22.51	0.060	NS
	G4	-34.57	0.020	S	-32.48	0.005	S	-31.12	0.003	S	-27.01	0.020	S	-32.62	0.004	S	-27.91	0.022	S
G2	**G1**	13.96	0.450	NS	11.19	0.383	NS	10.42	0.332	NS	5.06	0.884	NS	10.14	0.432	NS	11.43	0.449	NS
	G3	-10.07	0.686	NS	-12.41	0.305	NS	-10.03	0.360	NS	-11.42	0.412	NS	-11.16	0.358	NS	-11.07	0.474	NS
	G4	-20.60	0.177	NS	-21.29	0.048	S	-20.69	0.028	S	-21.94	0.054	NS	-22.48	0.031	S	-16.48	0.190	NS
G3	**G1**	24.04	0.104	NS	23.60	0.029	S	20.46	0.030	S	16.49	0.162	NS	21.31	0.041	S	22.51	0.060	NS
	G2	10.07	0.686	NS	12.41	0.305	NS	10.03	0.360	NS	11.42	0.412	NS	11.16	0.358	NS	11.07	0.474	NS
	G4	-10.52	0.658	NS	-8.87	0.305	NS	-10.65	0.316	NS	-10.52	0.476	NS	-11.31	0.348	NS	-5.40	0.879	NS
G4	**G1**	34.57	0.020	S	32.48	0.005	S	31.12	0.003	S	27.01	0.020	S	32.62	0.004	S	27.91	0.022	S
	G2	20.60	0.177	NS	21.29	0.048	S	20.69	0.028	S	21.94	0.054	NS	22.48	0.031	S	16.48	0.190	NS
	G3	10.52	0.658	NS	8.87	0.561	NS	10.65	0.316	NS	10.52	0.476	NS	11.31	0.348	NS	5.40	0.879	NS

Table 28 Tukey's test for Mortality T7-T12

For treatment 7 there is a significant difference between G1(Open 2021)-G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.020 ,0.020 with mean difference -34.57,34.57 on the other hand the remaining groups doesn't have significant difference

For treatment 8 there is a significant difference between G1(Open 2021)- G3(Open 2022), G1(Open 2021)-G4(Protected 2022) , G2(Protected 2021)-G4(Protected 2022) ,G3(Open 2021)-G1(Open 2021) ,G4(Protected 2022)- G1(Open 2021), G4(Protected 2022)-G2(Protected 2022) with significant values 0.029,0.005,0.048, 0.029, 0.005,0.048,with mean difference -23.60,-32.48,-21.29,23.60,32.48,21.29 on the other hand the remaining group doesn't have significant difference

For treatment 9 there is a significant difference between G1(Open 2021)-G3(Open 2022), G1(Open 2021)- G4(Protected 2022),.G2(Protected 2021)- G4(Protected 2022), G3(Open 2022)-G1(Open 2021) ,G4(Protected 2022)-G1(Open 2021),G4(Protected 2022)-G2(Protected 2022) with significant values 0.030, 0.003, 0.028, 0.030, 0.003,0.028 with mean difference -20.46,-31.12, -20.69,20.46,31.12,20.69 on the other hand the remaining group doesn't have significant difference

For treatment 10 there is significant difference between G1(Open 2021)-G4(Protected 2022), G4(Protected 2022)-G1(Open 2021) with significant values 0.020, 0.020 with mean difference -27.01, 27.01 on the other hand the remaining groups doesn't have significant difference

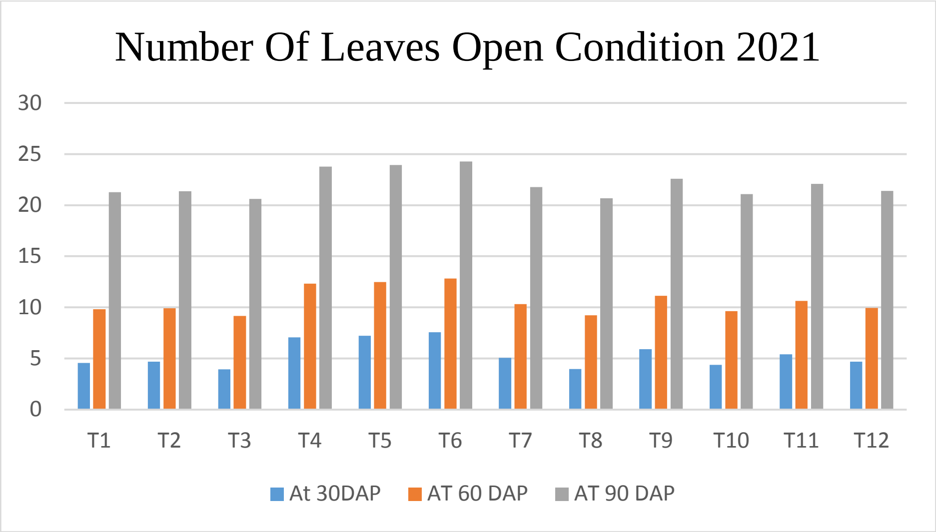
For treatment 11 there is significant difference between G1(Open 2021)- G3(Open 2022), G1(Open 2021)-G4(Protected 2022) , G2(Protected 2021)-G4(Protected 2022), G3(OPEN 2022)- G1(Open 2021), G4(Protected 2022)- G1(Open 2021),G4(Protected 2022) – G2(Protected 2021) with the significant values 0.041, 0.004, 0.031, 0.041, 0.004, 0.031 with mean difference -21.31, -32.62, -22.48, 21.31, 32.62, 22.48, on the other hand the remaining group doesn't have significant difference

For treatment 12 there is a significant difference between G1(Open 2021)-G4(Protected 2022),G4(Protected 2022)-G1(Open 2021) with significant values 0.022, 0.022 with mean difference -27.91, 27.91 on the other hand the remaining group doesn't have significant difference.

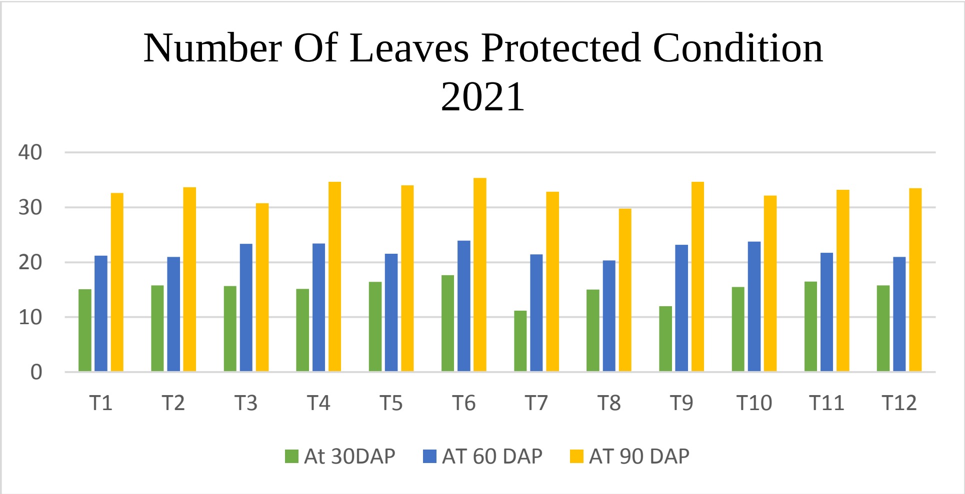
8.11: Impact of different growing media on Number of Leaves in Guava cuttings (*Psidium guajava* L.):

Treatment Symbol	2021								2022							
	Number of Leaves								Number of Leaves							
	Open Conditions				Protected Conditions				Open Conditions				Protected Conditions			
	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean
T1	1.57	4.68	7.66	4.64	3.01	6.12	9.10	6.08	1.91	5.02	8.00	4.98	3.14	6.25	9.23	6.21
T2	1.68	4.79	7.77	4.75	3.12	6.23	9.21	6.19	2.02	5.13	8.11	5.09	3.25	6.36	9.34	6.32
T3	2.40	5.51	8.49	5.47	3.84	6.95	9.93	6.91	2.72	5.83	8.81	5.79	3.97	7.08	10.06	7.04
T4	2.90	6.01	8.99	5.97	4.34	7.45	10.43	7.41	3.24	6.35	9.33	6.31	4.47	7.58	10.56	7.54
T5	2.03	5.14	8.12	5.10	3.47	6.58	9.56	6.54	2.37	5.48	8.46	5.44	3.60	6.71	9.69	6.67
T6	2.38	5.49	8.47	5.45	2.37	5.48	8.46	5.44	1.27	4.38	7.36	4.34	3.95	7.06	10.04	7.02
T7	2.08	5.19	8.17	5.15	3.52	6.63	9.61	6.59	2.42	5.53	8.51	5.49	3.65	6.76	9.74	6.72
T8	0.98	4.09	7.07	4.05	2.42	5.53	8.51	5.49	1.32	4.43	7.41	4.39	2.55	5.66	8.64	5.62
T9	1.88	4.99	7.97	4.95	3.82	6.93	9.91	6.89	2.22	5.33	8.31	5.29	3.45	6.56	9.54	6.52
T10	1.38	4.49	7.47	4.45	2.82	5.93	8.91	5.89	1.72	4.83	7.81	4.79	2.95	6.06	9.04	6.02
T11	0.93	4.04	7.02	4.00	3.32	6.43	9.41	6.39	2.74	5.85	8.83	5.81	2.50	5.61	8.59	5.57
T12	1.70	4.81	7.79	4.77	3.14	6.25	9.23	6.21	2.04	5.15	8.13	5.11	3.27	6.38	9.36	6.34
Mean	1.83	4.94	7.92	4.89	3.27	6.38	9.36	6.33	2.17	5.28	8.26	5.23	3.40	6.51	9.49	6.46
CD at 5%	0.43	0.42	0.37	0.36	0.41	0.38	0.44	0.51	0.43	0.32	0.38	0.48	0.36	0.49	0.39	0.46

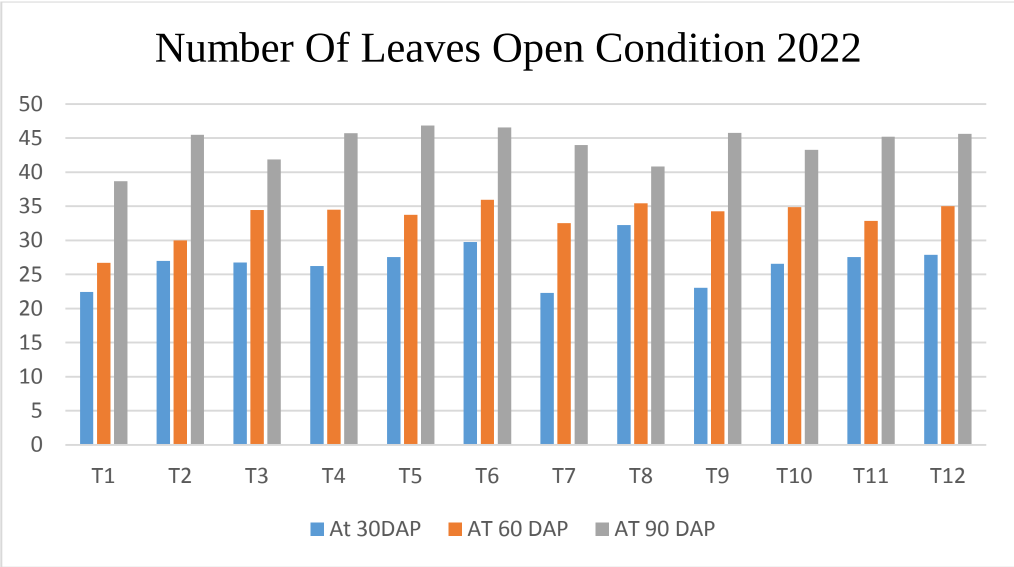
Table 29 Number of Leaves



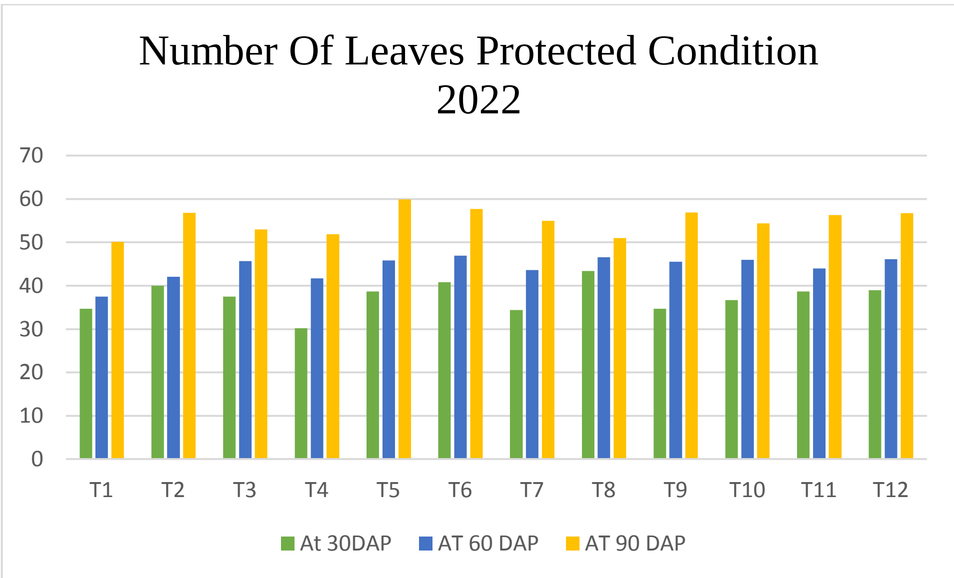
Graph 34 Number of Leaves Open Condition 2021



Graph 35 Number of Leaves Protected Condition 2022



Graph 36 Number of Leaves Open Condition 2022



Graph 37 Number of Leaves Protected Condition 2022

Tukey's test for Number of Leaves:

Groups		T1			T2			T3			T4			T5			T6		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-11.09	0.433	NS	-11.48	0.467	NS	-12.01	0.310	NS	-10.01	0.613	NS	-9.46	0.640	NS	-10.77	0.467	NS
	G3	-17.40	0.134	NS	-22.17	0.072	NS	-23.14	0.028	S	-21.12	0.109	NS	-21.51	0.095	NS	-22.54	0.051	NS
	G4	-28.87	0.014	S	-34.29	0.008	S	-34.15	0.003	S	-26.86	0.040	S	-33.62	0.011	S	-33.61	0.006	S
G2	**G1**	11.09	0.433	NS	11.48	0.467	NS	12.01	0.310	NS	10.01	0.613	NS	9.46	0.640	NS	10.77	0.467	NS
	G3	-6.31	0.802	NS	-10.69	0.522	NS	-11.12	0.368	NS	-11.10	0.537	NS	-12.05	0.460	NS	-11.77	0.397	NS
	G4	-17.78	0.125	NS	-22.80	0.064	NS	-22.13	0.035	S	-16.84	0.228	NS	-24.16	0.059	NS	-22.84	0.048	S
	G2	6.31	0.802	NS	10.69	0.522	NS	11.12	0.368	NS	11.10	0.537	NS	12.05	0.460	NS	11.77	0.397	NS
	G4	-11.47	0.407	NS	-12.11	0.425	NS	-11.01	0.375	NS	-5.74	0.887	NS	-12.10	0.457	NS	-11.07	.0445	NS
G4	**G1**	28.87	0.014	S	34.29	0.008	S	34.15	0.003	S	26.86	0.040	S	33.62	0.011	S	33.61	0.006	S
	G2	17.78	0.125	NS	22.80	0.064	NS	22.13	0.035	S	16.84	0.228	NS	24.16	0.059	NS	22.84	0.048	S
	G3	11.47	0.407	NS	12.11	0.425	NS	11.01	0.375	NS	5.74	0.887	NS	12.10	0.457	NS	11.07	0.445	NS

Table 30 Tukey's test for Number of Leaves T1-T6

For treatment 1 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.014 and with mean difference of -28.87, 28.87 on the other hand the remaining group doesn't have significant difference.

For treatment 2 there is a significant difference between G1(Open 2021) - G4(Protected 2022), G4(Protected 2022) - G1(Open 2021) With significant values 0.008 with mean difference -34.29, 34.29, on the other hand the remaining group doesn't have significant difference.

For treatment 3 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.028 ,0.003, 0.035 and mean difference -23.14, -34.15, -22.13, 23.14, 34.15 and 22.13 on the other hand the remaining group doesn't have significant difference.

For treatment 4 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.040 and with mean difference of -26.86, 26.86 on the other hand the remaining group doesn't have significant difference.

For treatment 5 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.011 and with mean difference of -33.62, 33.62 on the other hand the remaining group doesn't have significant difference.

For treatment 6 there is a significant difference between G1(Open 2021)- G4(Protected 2022), G2(Protected 2021) – G4(Protected 2022) G4(Protected 2022) - G1(Open 2021), G4(Protected 2022) – G2(Protected 2021) with significant values 0.048, 0.006 with mean difference of -33.61, -22.84, 33.61 and 22.84 on the other hand the remaining group doesn't have significant difference.

Groups		T7			T8			T9			T10			T11			T12		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-9.44	0.680	NS	-10.40	0.264	NS	-10.06	0.668	NS	-12.11	0.365	NS	-11.09	0.457	NS	-11.41	0.443	NS
	G3	-20.55	0.140	NS	-24.90	0.006	S	-21.16	0.148	S	-23.22	0.041	S	-22.50	0.055	NS	-24.16	0.042	S
	G4	-31.96	0.021	S	-35.68	0.001	S	-32.49	0.024	S	-34.00	0.005	S	-33.60	0.007	S	-35.28	0.005	S
G2	**G1**	9.44	0.680	NS	10.40	0.264	NS	10.06	0.668	NS	12.11	0.365	NS	11.09	0.457	NS	11.41	0.443	NS
	G3	-11.10	0.568	NS	-14.49	0.090	NS	-11.09	0.602	NS	-11.11	0.432	NS	-11.40	0.436	NS	-12.74	0.358	NS
	G4	-22.52	0.100	NS	-25.27	0.005	S	-22.42	0.121	S	-21.88	0.054	NS	-22.50	0.055	NS	-23.86	0.044	S
G3	**G1**	20.55	0.140	NS	24.90	0.006	S	21.16	0.148	S	23.22	0.041	S	22.50	0.055	NS	24.16	0.042	S
	G2	11.10	0.568	NS	14.49	0.090	NS	11.09	0.602	NS	11.11	0.432	NS	11.40	0.436	NS	12.74	0.358	NS
	G4	-11.41	0.548	NS	-10.78	0.240	NS	-11.33	0.587	NS	-10.77	0.456	NS	-11.10	0.457	NS	-11.12	0.463	NS
G4	**G1**	31.96	0.021	S	35.68	0.001	S	32.49	0.024	S	34.00	0.005	S	33.60	0.007	S	35.28	0.005	S
	G2	22.52	0.100	NS	25.27	0.005	S	22.42	0.121	S	21.88	0.054	NS	22.50	0.055	NS	23.86	0.044	S
	G3	11.41	0.548	NS	10.78	0.240	NS	11.33	0.587	NS	10.77	0.456	NS	11.10	0.457	NS	11.12	0.463	NS

Table 31 Tukey's test for Number of Leaves T7-T12

For treatment 7 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.021 and with mean difference of -31.96, 31.96 on the other hand the remaining group doesn't have significant difference.

For treatment 8 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.006 ,0.001, 0.005 and mean difference -24.90, -35.68, -25.27, 24.90, 35.68 and 25.27 on the other hand the remaining group doesn't have significant difference.

For treatment 9 there is a significant difference between G1(Open 2021) - G4(Protected 2022), G4(Protected 2022) - G1(Open 2021) With significant values 0.024 with mean difference -34.29, 34.29, on the other hand the remaining group doesn't have significant difference.

For treatment 10 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), and G4(Protected 2022) - G1(Open 2021) With significant values 0.041 ,0.005 and mean difference -23.22, -34.00, 23.22 and 34.00, on the other hand, the remaining group doesn't have significant difference.

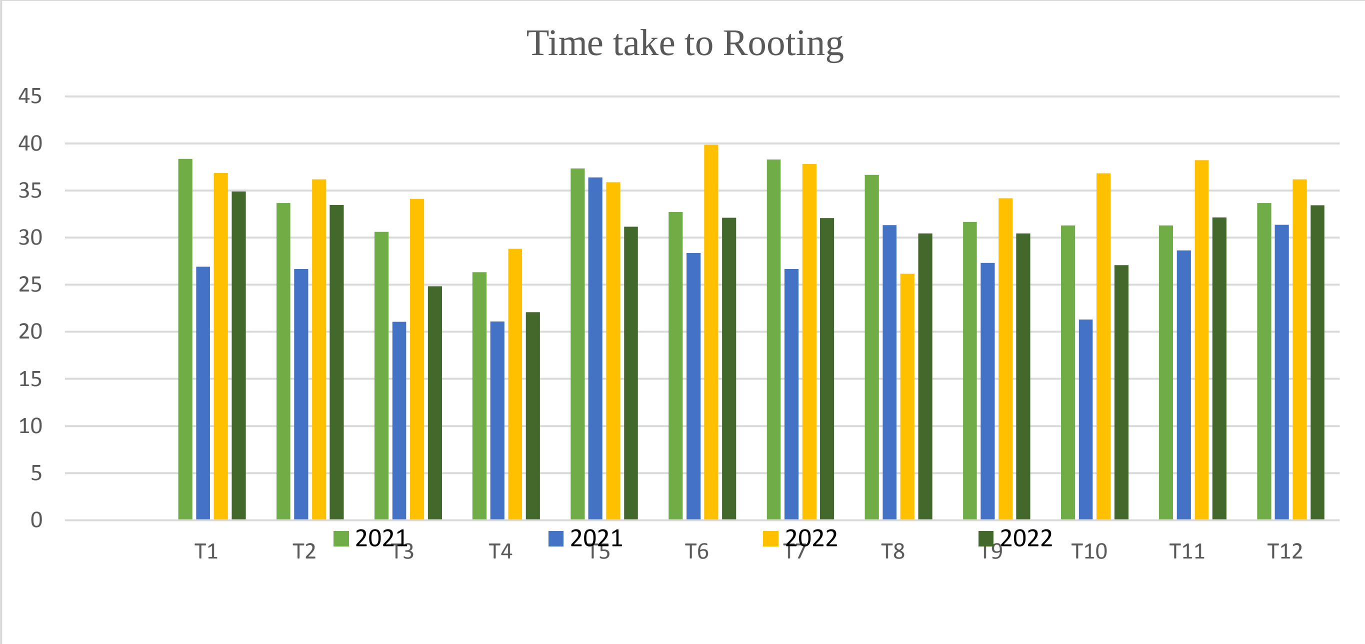
For treatment 11 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.007 and with mean difference of -33.60, 33.60 on the other hand the remaining group doesn't have significant difference.

For treatment 12 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.042 ,0.005, 0.044 and mean difference -24.16, -35.28, -23.86, 24.16, 35.28 and 23.86 on the other hand the remaining group doesn't have significant difference.

8.12: Impact of different growing media on Time taken to Rooting in Guava cuttings (*Psidium guajava* L.):

Treatment Symbol	**2021**		**2022**	
	Time Taken to Rooting		**Time Taken to Rooting**	
	Open Conditions (Days)	Protected Conditions (Days)	Open Condition (Days)	Protected Conditions (Days)
T1	38.36	26.90	36.88	34.89
T2	33.66	26.67	36.18	33.46
T3	30.60	21.06	34.12	24.85
T4	26.33	21.10	28.83	22.08
T5	37.36	36.38	35.88	31.17
T6	32.71	28.36	39.85	32.10
T7	38.31	26.68	37.83	32.08
T8	36.66	31.33	26.18	30.43
T9	31.68	27.33	34.20	30.45
T10	31.31	21.31	36.83	27.08
T11	31.31	28.66	38.23	32.15
T12	33.68	31.36	36.20	33.45
CD at 5%	2.41	3.06	2.73	2.56

Table 32 Time taken to Rooting



Graph 38 Time Taken to Rooting

Tukey’s test for Time taken for Rooting:

Groups		T1			T2			T3			T4			T5			T6		
		M.D	P-value	Status	M.D	P-Value	Status	M.D	P-Value	Status	M.D	P-Value	Status	M.D	P-Value	Status	M.D	P-Value	Status
G1	G3	-6.63	0.315	NS	-12.43	0.346	NS	-6.67	0.435	NS	-16.03	0.073	NS	-6.73	0.046	S	-6.68	0.531	NS
	G3	-30.36	0.033	S	-30.74	0.015	S	-16.73	0.054	NS	-36.76	0.003	S	-30.16	0.000	S	-16.47	0.066	NS
	G4	-30.36	0.003	S	-30.63	0.001	S	-30.56	0.005	S	-41.67	0.000	S	-36.16	0.000	S	-30.33	0.012	S
G3	G1	6.63	0.315	NS	12.43	0.346	NS	6.67	0.435	NS	16.03	0.073	NS	6.73	0.046	S	6.66	0.531	NS
	G3	-12.34	0.365	NS	-12.33	0.353	NS	-6.75	0.453	NS	-13.77	0.167	NS	-11.43	0.013	S	-6.56	0.544	NS
	G4	-30.65	0.030	S	-30.31	0.017	S	-30.61	0.044	S	-35.65	0.006	S	-16.45	0.000	S	-30.34	0.074	NS
G3	G1	30.36	0.033	S	30.74	0.015	S	16.73	0.054	NS	36.76	0.003	S	30.16	0.000	S	16.47	0.066	NS
	G3	12.34	0.365	NS	12.33	0.353	NS	6.75	0.453	NS	13.77	0.167	NS	11.43	0.013	S	6.56	0.544	NS
	G4	-12.30	0.366	NS	-6.66	0.361	NS	-12.65	0.366	NS	-13.16	0.150	NS	-6.03	0.067	NS	-12.75	0.456	NS
G4	G1	30.56	0.003	S	30.63	0.001	S	30.56	0.005	S	41.67	0.000	S	36.16	0.000	S	30.33	0.012	S
	G3	30.65	0.030	S	30.31	0.017	S	30.61	0.044	S	35.65	0.006	S	16.45	0.000	S	30.34	0.074	NS
	G3	12.30	0.366	NS	6.66	0.361	NS	12.65	0.366	NS	13.16	0.150	NS	6.03	0.067	NS	12.75	0.456	NS

Table 33 Tukey's test for Time taken for Rooting T1-T6

For treatment 1 there is a significant difference between the groups G1(Open 2021) - G3(Open 2022), G1(Open 2021) – G4(Protected 2022), G3(Open 2022)-G1(Open 2021) and G4(Protected 2022)-G1(Open 2021) with significance value of 0.033, 0.030 and mean difference of -30.36, -30.56, 30.36 30.56. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 2 there is a significant difference between the groups G1(Open 2021)-G3(Open2022) G1(Open 2021) – G4(Protected 2022) G3(Open 2022)- G1(Open 2021) and G4(Protected 2022)- G1(Open 2021) with significance value of 0.015, 0.001, 0.017 and mean difference of -30.74, -30.63 and 30.31. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 3 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022) and G4(Protected 2022)-G1(Open 2021) with significance value of 0.005, 0.044 and mean difference of -30.56, -30.61, 30.56 and 30.61. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 4 there is a significant difference between the groups G1(Open 2021) – G3 (Open 2022) G1(Open 2021) – G4(Protected 2022) G3(Open 2021) – G1(Open 2021) and G4(Protected 2022)-G1(Open 2021) with significance value of 0.003, 0.000, 0.006 and mean difference of -36.76, -41.67, -35.65, 36.76, 41.67 and 35.65. On the other hand, the remaining groups doesn't have mean significant difference.

For treatment 5 there is a significant difference between the groups G1(Open 2021) – G2(Protected 2021) G1 (Open 2021) - G3(Open 2022) G1(Open 2021)– G4(Protected 2022), G2(Protected 2022) – G1(Open 2021) G3(Open 2022) – G1(Open 2021) and G4(Protected 2022)-G1(Open 2021), with significance value of 0.000, and mean difference of -30.16 ,-36.16, -16.45, -11.43, 30.16, 36.16, 16.45, 11.43 and 30.16 and the remaining groups doesn't have mean significant difference.

For treatment 6 there is a significant difference between the groups G1(Open 2021) – G4(Protected 2022) and G4(Protected 2022)-G1(Open 2021) with significance value of 0.010, 0.010 and mean difference of -30.33, 30.33. On the other hand, the remaining groups doesn't have mean significant difference.

Groups		T7			T8			T9			T10			T11			T12		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G3	**G5**	-4.43	0.545	NS	-9.35	0.379	NS	-30.05	0.559	NS	-33.65	0.375	NS	-9.83	0.375	NS	-5.58	0.798	NS
	G3	-9.65	0.066	NS	-33.48	0.080	NS	-53.56	0.008	S	-33.37	0.570	NS	-53.37	0.054	S	-37.38	0.006	NS
	G4	-55.55	0.000	S	-38.50	0.008	S	-33.07	0.003	S	-54.85	0.055	S	-54.63	0.033	S	-58.59	0.005	S
G5	**G3**	4.43	0.545	NS	9.35	0.379	NS	30.56	0.559	NS	33.65	0.375	NS	9.83	0.375	NS	5.58	0.798	NS
	G3	-5.55	0.438	NS	-5.35	0.935	NS	-33.50	0.355	NS	-3.75	0.993	NS	-33.34	0.567	NS	-35.30	0.533	NS
	G4	-53.35	0.003	S	-9.04	0.386	NS	-53.03	0.030	S	-33.53	0.577	N S	-34.78	0.338	NS	-53.33	0.036	S
G3	**G3**	9.65	0.066	NS	33.48	0.080	NS	53.56	0.355	S	33.37	0.570	NS	53.37	0.054	S	37.38	0.066	NS
	G5	5.55	0.438	NS	5.35	0.935	NS	33.50	0.355	NS	3.75	0.993	NS	33.34	0.567	NS	35.30	0.533	NS
	G4	-35.89	0.005	S	-6.75	0.395	NS	-9.53	0.566	NS	-33.47	0.385	NS	-3.43	0.958	NS	-33.53	0.585	NS
G4	**G3**	55.55	0.000	S	38.50	0.008	S	33.07	0.003	S	54.85	0.055	S	54.63	0.033	S	58.59	0.005	S
	G5	53.35	0.003	S	9.04	0.386	NS	53.03	0.030	S	33.53	0.577	NS	34.78	0.338	NS	53.33	0.036	S
	G3	35.89	0.005	S	6.75	0.395	NS	9.53	0.566	NS	33.47	0.385	NS	3.43	0.958	NS	33.53	0.585	NS

Table 34 Tukey's test for Time taken for Rooting T7-T12

For treatment 7 there is a significant difference between G1(Open 2021) –G4(Protected 2022), G4(Protected 2022) – G1(Open 2021) with the significant values of 0.024, 0.024 and mean difference -20.93,20.93 on the other hand the remaining groups doesn't have significant difference

For treatment 8 there is a significant difference between G1(Open 2021) – G3(Open 2022). G1(Open 2021) - G4(Protected 2022). G3(Open 2022) – G1(Open 2021). G4(Protected 2022) - G1(Open 2021) with the significant values of 0.0 30 ,0.009, 0.030. 0.009 and mean difference -21.73, -27.28,21.73,27.28 on the other hand the remaining groups doesn't have significant difference.

For treatment 9 there is a significant difference between G1(Open 2021) – G3(Open 2022), G2(Protected 2021) – G4(Protected 2022), G4(Protected 2022) – G1(Open 2021) with the significant values of 0.003, 0.031, 0.003, 0.031 and mean difference -31.36, -21.08, 31.36, 21.08 on the other hand the remaining groups doesn't have significant difference.

For treatment 10 there is a significant difference between G1(Open 2021) – G3(Open 2022), G1(Open 2021) – G4(Protected 2022). G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021). G4(Protected 2022) - G1(Open 2021), G4(Protected 2022) – G2(property 2021) with the significant values of 0.025 ,0.001, 0.018, 0.025, 0.001, 0.018 and mean difference -16.16, -27.43, -17.09,16.16,27.43,17.09 on the other hand the remaining groups doesn't have significant difference.

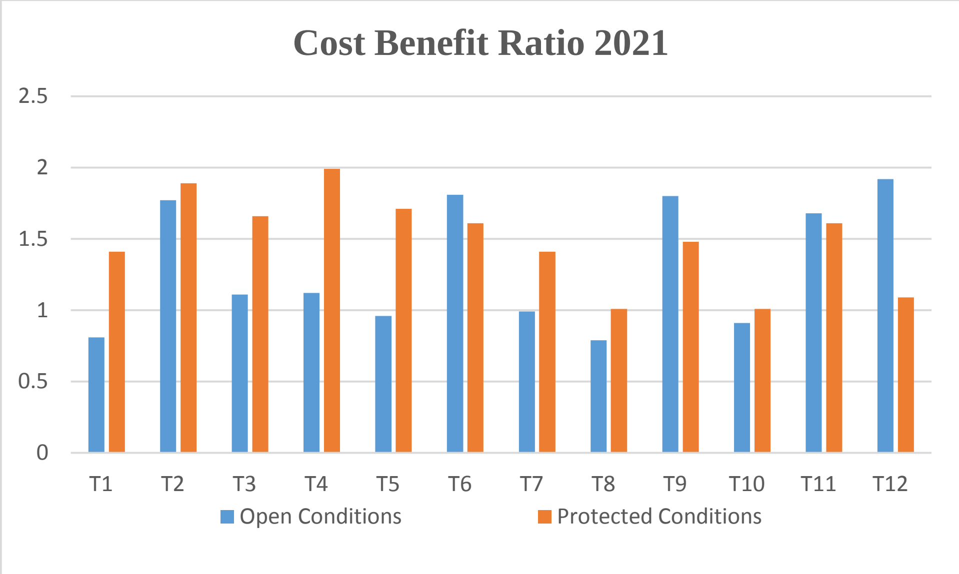
For treatment 11 there is a significant difference between G1(Open 2021) – G3(Open 2022), G1(Open 2021) – G4(Protected 2022), G3(Open 2022) – G1(Open 2021) . G4(Protected 2022) – G1(Open 2021), with the significant values 0.049, 0.011, 0.049, 0.011 and mean difference -20.94, -28.13, 20.94,28.13on the other hand the remaining groups doesn't have significant difference.

For treatment 12 there is a significant difference between G1(Open 2021) – G4(Protected 2022), and G4 (Protected 2022) – G1(Open 2021) with these the significant values 0.019 and 0.019 and mean difference -24.55, 24.55 on the other hand the remaining groups doesn't have significant difference.

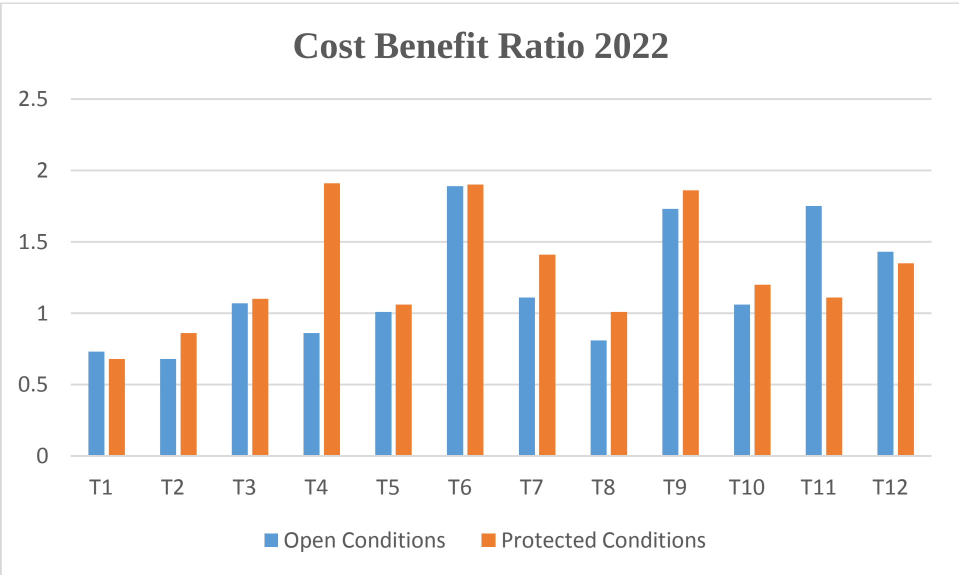
8.13: Effect of different growing media on Cost Benefit Ratio of Cutting in Guava cuttings (*Psidium guajava* L.):

Treatment Symbol	2021		2022	
	Cost Benefit Ratio		Cost Benefit Ratio	
	Open Conditions	Protected Conditions	Open Conditions	Protected Conditions
T1	0.81	1.41	0.73	0.68
T2	1.77	1.89	0.68	0.86
T3	1.11	1.66	1.07	1.10
T4	1.12	1.99	0.86	1.91
T5	0.96	1.71	1.01	1.06
T6	1.81	1.61	1.89	1.90
T7	0.99	1.41	1.11	1.41
T8	0.79	1.01	0.81	1.01
T9	1.80	1.48	1.73	1.86
T10	0.91	1.01	1.06	1.20
T11	1.68	1.61	1.75	1.11
T12	1.92	1.09	1.43	1.35
CD at 5%	0.23	0.20	0.24	0.25

Table 35 Cost Benefit Ratio



Graph 39 Cost Benefit Ratio 2021



Graph 40 Cost Benefit Ratio 2022

Tukey's test for Cost Benefit Ratio

Groups		T1			T2			T3			T4			T5			T6		
		M.D	P-value	Status	M.D	P-Value	Status	M.D	P-Value	Status	M.D	P-Value	Status	M.D	P-Value	Status	M.D	P-Value	Status
G1	G2	-9.07	0.374	NS	-9.84	0.726	NS	-9.38	0.330	NS	-4.18	0.842	NS	-9.48	0.091	NS	-12.01	0.126	NS
	G3	-21.29	0.043	S	-20.74	0.069	NS	-22.08	0.031	S	-17.64	0.060	NS	-22.19	0.003	S	-22.02	0.007	S
	G4	-26.83	0.013	S	-27.19	0.028	S	-32.84	0.003	S	-27.29	0.003	S	-26.97	0.001	S	-31.31	0.001	S
G2	G1	9.07	0.374	NS	9.84	0.726	NS	9.38	0.330	NS	4.18	0.842	NS	9.48	0.091	NS	12.01	0.126	NS
	G3	-10.24	0.433	NS	-10.90	0.447	NS	-10.70	0.377	NS	-9.47	0.188	NS	-10.71	0.99	NS	-10.01	0.227	NS
	G4	-17.77	0.143	NS	-17.37	0.202	NS	-21.46	0.036	S	-23.9	0.008	S	-17.47	0.024	S	-19.29	0.017	S
G3	G1	21.29	0.043	S	20.74	0.069	NS	22.08	0.031	S	17.64	0.060	NS	22.19	0.003	S	22.02	0.007	S
	G2	10.24	0.433	NS	10.90	0.447	NS	10.70	0.377	NS	9.47	0.188	NS	10.71	0.99	NS	10.01	0.227	NS
	G4	-7.73	0.824	NS	-4.44	0.917	NS	-10.76	0.372	NS	-9.67	0.179	NS	-4.76	0.671	NS	-9.28	0.277	NS
G4	G1	26.83	0.813	S	27.19	0.028	S	32.84	0.003	S	27.29	0.003	S	26.97	0.001	S	31.31	0.001	S
	G2	17.77	0.143	NS	17.37	0.202	NS	21.46	0.036	S	23.9	0.008	S	17.47	0.024	S	19.29	0.017	S
	G3	7.73	0.824	NS	4.44	0.917	NS	10.76	0.372	NS	9.67	0.179	NS	4.76	0.671	NS	9.28	0.277	NS

Table 36 Tukey's test for Cost Benefit Ratio

For treatment 1 there is a significant difference between G1(Open 2021) – G3(Open 2022) , G1(Open 2021) – G4(Protected 2022) ,G3(Open 2022) - G1(Open 2021) , G4(Protected 2022) - G1(Open 2021) with the significant values of 0.043, 0.013,0.043,0.813 and mean difference-21.29, -26.83, 21.29,26.83 on the other hand the remaining groups doesn't have significant difference

For treatment 2 there is a significant difference between G1(Open 2021) - G4(Protected 2022) ,and G4(Protected 2022) - G1(Open 2021) with the significant values of 0.028 , 0.028 and the mean difference -20.74, 20.74 on the other hand the remaining groups doesn't have significant difference

For treatment 3 there is a significant difference between G1(Open 2021) – G3(Open 2022) ,G1(Open 2021) – G4(Protected 2022) , G2(Protected -2021) - G4(Protected 2022) , G3(Open 2022) - G1(Open 2021) , G4(Protected) – G1(Open 2021) , G4(Protected 2022) – G2(Protected 2021) with the significant values of 0.031, 0.003, 0.036, 0.031 ,0.003 ,0.036 and mean difference -22.08,-32..84, -21.46, 22.08, 32.84, 21.46 on the other hand the remaining groups doesn't have significant difference

For treatment 4 there is a significant difference between G1(Open 2021) – G4(Protected 2022) , G2(Protected 2021) - G4(Protected 2022), G4(Protected 2022) – G1(Open 2021) , G4(Protected 2022) – G2(Protected 2021) with the significant values of 0.003, 0.008, 0.003, 0.008 with mean difference -27.29,-23.11,27.29,23.11 on the other hand the remaining groups doesn't have significant difference

For treatment 5 there is a significant difference between G1(Open 2021) - G3(Open 2022) , G1(Open 2021) – G4(Protected 2022) , G2(Protected 2021) – G4(Protected 2022) , G3(Open 2022) – G1(Open 2021) ,G4(Protected 2022) – G1(Open 2021) , G4(Protected 2021)with the significant values of 0.003, 0.001, 0.024, 0.003, 0.001, 0.024 and mean difference -22.19, -26.95, -15.47, 22.19, 26.95, 15.47 on the other hand the remaining groups doesn't have significant difference.

Groups		T7			T8			T9			T10			T11			T12		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G1**	-4.79	0.819	NS	-9.64	0.449	NS	-10.18	0.469	NS	-10.44	0.160	NS	-10.61	0.415	NS	-10.17	0.411	NS
	G4	-15.81	0.087	NS	-11.74	0.040	S	-16.10	0.097	NS	-16.16	0.015	S	-10.94	0.049	S	-14.94	0.196	NS
	G4	-10.94	0.014	S	-17.18	0.009	S	-41.46	0.004	S	-17.44	0.001	S	-18.14	0.011	S	-14.55	0.019	S
G2	**G1**	4.79	0.819	NS	9.64	0.449	NS	10.18	0.469	NS	10.44	0.160	NS	10.61	0.415	NS	10.17	0.411	NS
	G4	-11.01	0.178	NS	-11.08	0.170	NS	-5.91	0.755	NS	-5.81	0.568	NS	-10.41	0.446	NS	-4.67	0.944	NS
	G4	-16.14	0.080	NS	-17.64	0.077	NS	-11.08	0.041	S	-17.09	0.018	S	-17.51	0.104	NS	-14.18	0.181	NS
G3	**G1**	15.81	0.087	NS	11.74	0.040	S	16.10	0.097	NS	16.16	0.015	S	10.94	0.049	S	14.94	0.196	NS
	G1	11.01	0.178	NS	11.08	0.170	NS	5.91	0.755	NS	5.81	0.568	NS	10.41	0.446	NS	4.67	0.944	NS
	G4	-5.11	0.801	NS	-5.55	0.800	NS	-15.16	0.115	NS	-11.17	0.119	NS	-7.18	0.697	NS	-10.61	0.486	NS
G4	**G1**	10.94	0.014	S	17.18	0.009	S	41.46	0.004	S	17.44	0.001	S	18.14	0.011	S	14.55	0.019	S
	G1	16.14	0.080	NS	17.64	0.077	NS	11.08	0.041	S	17.09	0.018	S	17.51	0.104	NS	14.18	0.181	NS
	G4	5.11	0.801	NS	5.55	0.800	NS	15.16	0.115	NS	11.17	0.119	NS	7.18	0.697	NS	10.61	0.486	NS

Table 37 Tukey's test for Cost Benefit Ratio T7-T12

For treatment 7 there is a significant difference between G1(Open 2021) –G4(Protected 2022), G4(Protected 2022) – G1(Open 2021) with the significant values of 0.024, 0.024 and mean difference -10.94,10.94 on the other hand the remaining groups doesn't have significant difference

For treatment 8 there is a significant difference between G1(Open 2021) – G3(Open 2022). G1(Open 2021) - G4(Protected 2022). G3(Open 2022) – G1(Open 2021). G4(Protected 2022) - G1(Open 2021) with the significant values of 0.0 30 ,0.009, 0.030. 0.009 and mean difference -11.74, -17.18,11.74,17.18 on the other hand the remaining groups doesn't have significant difference.

For treatment 9 there is a significant difference between G1(Open 2021) – G3(Open 2022), G2(Protected 2021) – G4(Protected 2022), G4(Protected 2022) – G1(Open 2021) with the significant values of 0.003, 0.031, 0.003, 0.031 and mean difference -41.46, -11.08, 41.46, 21.08 on the other hand the remaining groups doesn't have significant difference.

For treatment 10 there is a significant difference between G1(Open 2021) – G3(Open 2022), G1(Open 2021) – G4(Protected 2022). G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021). G4(Protected 2022) - G1(Open 2021), G4(Protected 2022) – G2(property 2021) with the significant values of 0.025 ,0.001, 0.018, 0.025, 0.001, 0.018 and mean difference -16.16, -17.44, -17.07,16.16,27.43,17.09 on the other hand the remaining groups doesn't have significant difference.

For treatment 11 there is a significant difference between G1(Open 2021) – G3(Open 2022), G1(Open 2021) – G4(Protected 2022), G3(Open 2022) – G1(Open 2021) . G4(Protected 2022) – G1(Open 2021), with the significant values 0.049, 0.011, 0.049, 0.011 and mean difference -10.94, -18.13, 10.94,18.13on the other hand the remaining groups doesn't have significant difference.

For treatment 12 there is a significant difference between G1(Open 2021) – G4(Protected 2022), and G4 (Protected 2022) – G1(Open 2021) with these the significant values 0.019 and 0.019 and mean difference -14.55, 14.55 on the other hand the remaining groups doesn't have significant difference.

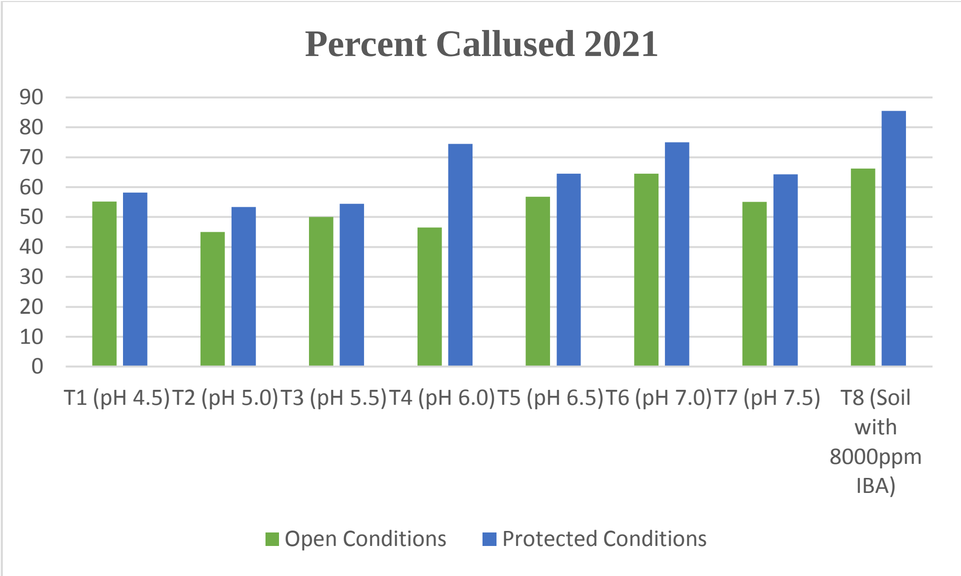
Exp.2: Studies of rooting media pH on rooting behaviour of semi hardwood stem cuttings of guava (*Psidium guajava* L.) under Himalayan foothill conditions.:

pH Analysis of Parameters in Guava is a process of determining the acidity or alkalinity of guava fruit juice by measuring the pH value. It is important to accurately measure the pH of guava juice to ensure the quality of the final product. The pH of guava juice is typically between 4.0 and 5.0, with the optimum pH being 4.5–5.0. The pH of the juice is influenced by factors such as the ripeness of the fruit, the variety of guava, and the growing conditions. pH analysis can help determine the optimal ripeness of the fruit for juice production, as well as identify any undesirable acids or other compounds in the juice. The pH of guava juice can also be used to determine the optimal storage temperature and shelf life.

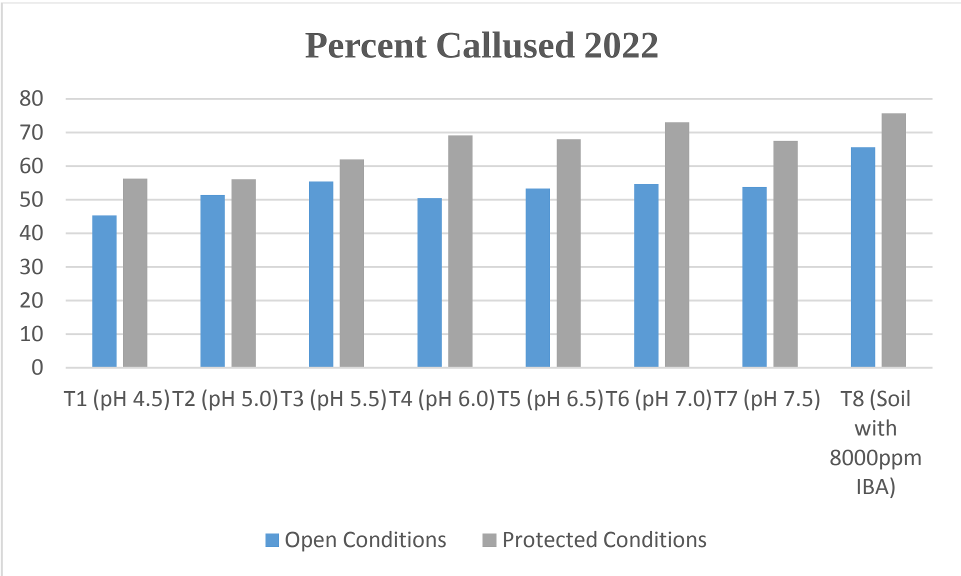
8.14: Impact of different growing media pH on Per cent (%) Callused of Cutting in Guava (*Psidium guajava* L.):

Treatment Symbol	2021		2022	
	Per cent (%) Callused		Per cent (%) Callused	
	Open Conditions	Protected Conditions	Open Conditions	Protected Conditions
	At 30DAP	At 30DAP	At 30DAP	At 30DAP
T1 (pH 4.5)	55.23	58.22	45.34	56.25
T2 (pH 5.0)	45.06	53.33	51.43	56.13
T3 (pH 5.5)	50.02	54.44	55.40	62.00
T4 (pH 6.0)	46.53	74.43	50.46	69.15
T5 (pH 6.5)	56.84	64.55	53.35	68.04
T6 (pH 7.0)	64.54	75.00	54.63	73.05
T7 (pH 7.5)	55.11	64.25	53.84	67.47
T8 (Soil with 8000ppm IBA)	66.23	85.50	65.65	75.66
CD **at 5%**	4.23	6.43	4.06	3.91

Table 38 Per cent (%) Callused pH



Graph 41 Per cent (%) Callused 2021



Graph 42 Per cent (%) Callused 2022

Tukey's test for Per cent (%) Callused pH:

Groups		T1			T2			T3			T4		
		M.D	P-value	Status	M.D	P-Value	Status	M.D	P-Value	Status	M.D	P-Value	Status
G1	**G2**	-10.67	0.524	NS	-7.24	0.476	NS	-7.12	0.867	NS	-8.66	0.528	NS
	G2	-40.82	0.102	NS	-16.40	0.017	S	-20.66	0.166	NS	-18.84	0.062	NS
	G4	-20.60	0.018	S	-26.60	0.001	S	-22.15	0.025	S	-26.25	0.006	S
G2	**G1**	10.67	0.524	NS	7.24	0.476	NS	7.12	0.867	NS	8.66	0.528	NS
	G2	-6.86	0.602	NS	-12.06	0.140	NS	-12.52	0.502	NS	-10.15	0.408	NS
	G4	-16.62	0.128	NS	-22.26	0.008	S	-25.02	0.102	NS	-20.56	0.042	S
G2	**G1**	40.82	0.102	NS	16.40	0.017	S	20.66	0.166	NS	18.84	0.062	NS
	G2	6.86	0.602	NS	12.06	0.140	NS	12.52	0.502	NS	10.15	0.408	NS
	G4	-6.76	0.610	NS	-10.20	0.225	NS	-11.46	0.622	NS	-10.41	0.286	NS
G4	**G1**	20.60	0.018	S	26.60	0.001	S	22.15	0.025	S	26.25	0.006	S
	G2	16.62	0.128	NS	22.26	0.008	S	25.02	0.102	NS	20.56	0.042	S
	G2	6.76	0.610	NS	10.20	0.225	NS	11.46	0.622	NS	10.41	0.286	NS

Table 39 Tukey's test for Per cent (%) Callused pH T1-T4

For treatment 3 there is a significant difference between G1(Open 2021) - G4(Protected 2022), G4(Protected 2022) - G1(Open 2021) With significant values 0.035 with mean difference -22.15, 22.15, on the other hand the remaining group doesn't have significant difference.

For treatment 4 there is a significant difference between G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) – G4(Protected 2022), G4(Protected 2022) - G1(Open 2021) and

G4(Protected 2022) – G2(Protected 2021) with significant values 0.006, 0.042 and with mean difference of -26.25, -20.56, 26.25 and 20.56 on the other hand the remaining group doesn't have significant difference.

Groups		T5			T6			T7			T8		
		M.D	P-value	Status	M.D	P-Value	Status	M.D	P-Value	Status	M.D	P-Value	Status
G1	G2	-6.17	0.431	NS	-6.69	0.640	NS	-6.14	0.601	NS	-6.55	0.525	NS
	G3	-7.60	0.053	NS	-19.59	0.200	NS	-15.31	0.176	NS	-15.31	0.143	NS
	G4	-15.65	0.006	S	-29.49	0.042	S	-33.72	0.012	S	-25.35	0.022	S
G2	G1	6.17	0.431	NS	6.69	0.640	NS	6.14	0.061	NS	6.55	0.525	NS
	G3	-9.92	0.450	NS	-5.59	0.752	NS	-5.17	0.735	NS	-7.76	0.732	NS
	G4	-20.45	0.049	S	-15.79	0.226	NS	-23.55	0.070	NS	-17.50	0.157	NS
G3	G1	7.60	0.053	NS	19.59	0.200	NS	15.31	0.176	NS	15.31	0.143	NS
	G2	9.92	0.450	NS	5.59	0.752	NS	5.17	0.735	NS	7.76	0.732	NS
	G4	-6.55	0.402	NS	-9.90	0.690	NS	-15.41	0.255	NS	-6.03	0.562	NS
G4	G1	15.65	0.006	S	29.49	0.042	S	33.72	0.012	S	25.35	0.022	S
	G2	20.45	0.049	S	15.79	0.226	NS	23.55	0.070	NS	17.50	0.157	NS
	G3	6.55	0.402	NS	9.90	0.690	NS	15.41	0.255	NS	6.03	0.562	NS

Table 40 Tukey's test for Per cent (%) Callused pH T5-T8

For treatment 5 there is a significant difference between G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) – G4(Protected 2022), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) with significant values 0.006 and with mean difference of -15.65, -20.45, 15.65, 20.45 on the other hand the remaining group doesn't have significant difference.

For treatment 6 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.042 and with mean difference of -29.49, 29.49 on the other hand the remaining group doesn't have significant difference.

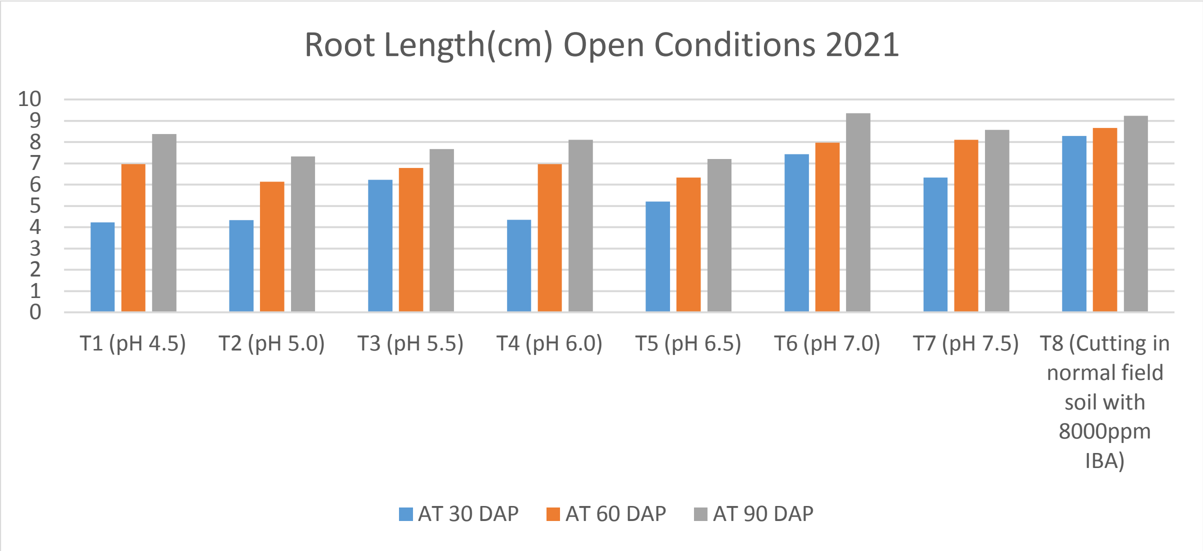
For treatment 7 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.012 and with mean difference of -33.72, 33.72 on the other hand the remaining group doesn't have significant difference.

For treatment 8 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.022 and with mean difference of -25.35, 25.35 on the other hand the remaining group doesn't have significant difference.

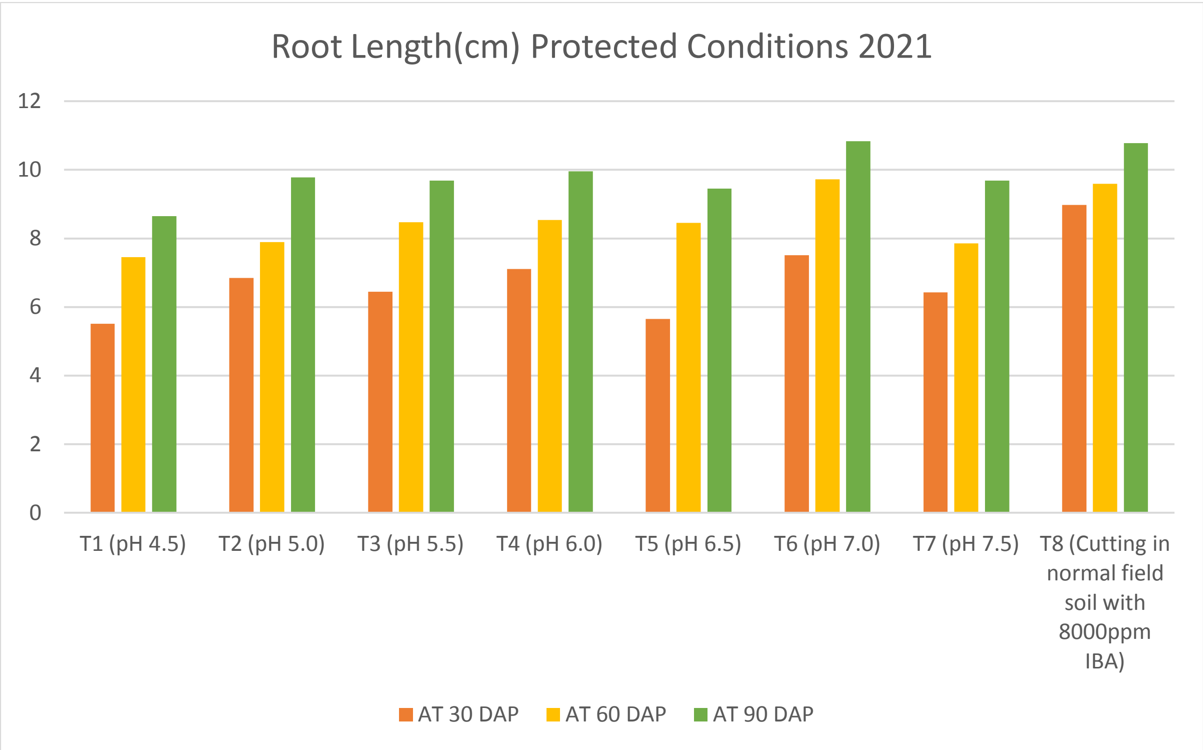
8.15: Impact of different growing media pH on Per cent (%) Rooted of Cutting in Guava (*Psidium guajava* L.):

Treatment Symbol	2021								2022							
	Per cent (%) Rooted								Per cent (%) Rooted							
	Open Conditions				Protected Conditions				Open Conditions				Protected Conditions			
	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean
T1 (pH 4.5)	38.75	44.01	55.45	46.07	59.25	64.11	74.00	65.79	45.66	53.05	64.05	54.25	56.40	65.93	71.66	64.66
T2 (pH 5.0)	32.71	37.96	49.41	40.03	53.66	59.00	67.48	60.05	36.05	48.66	58.88	47.86	43.79	53.32	68.99	55.37
T3 (pH 5.5)	39.50	44.75	56.20	46.82	62.96	67.99	75.66	68.87	40.00	48.85	55.45	48.10	57.74	62.27	76.98	65.66
T4 (pH 6.0)	47.85	53.10	64.55	55.17	55.58	61.87	74.05	63.83	46.90	54.66	63.31	54.96	54.64	59.17	65.09	59.63
T5 (pH 6.5)	46.35	51.60	63.05	53.67	49.66	57.25	73.15	60.02	44.45	52.66	62.08	53.06	52.19	59.72	67.65	59.85
T6 (pH 7.0)	58.15	63.40	74.85	65.47	73.40	75.65	80.78	76.61	58.80	61.69	68.54	63.01	71.04	75.57	81.65	76.09
T7 (pH 7.5)	56.98	65.23	72.68	64.96	66.88	71.45	76.98	71.77	61.66	64.25	73.36	66.42	67.54	74.07	78.68	73.43
T8 (Soil with 8000ppm IBA)	61.70	66.95	78.40	69.02	73.22	75.39	82.22	76.94	73.30	77.51	82.49	77.77	75.40	80.93	84.98	80.44
Mean	47.75	53.38	64.32	55.15	61.83	66.59	75.54	67.99	50.85	57.67	66.02	58.18	59.84	66.37	74.46	66.89
CD **at 5%**	5.80	6.71	5.81	5,78	4.63	4.32	5.37	4.32	6.78	4.73	5.41	5.98	6.32	5.52	3.98	5.01

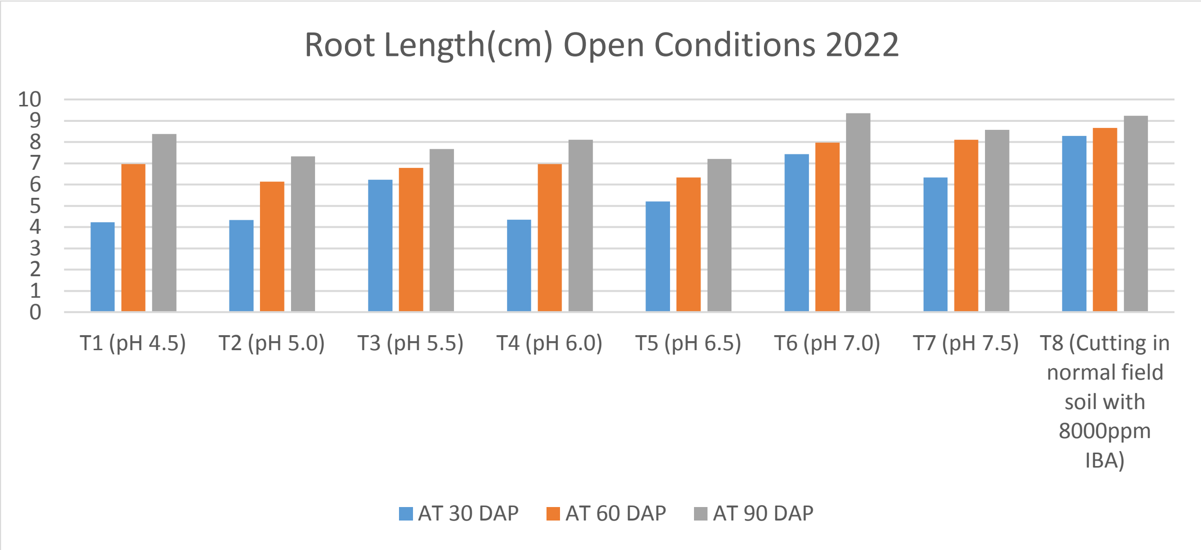
Table 41 Per cent (%) Rooted pH



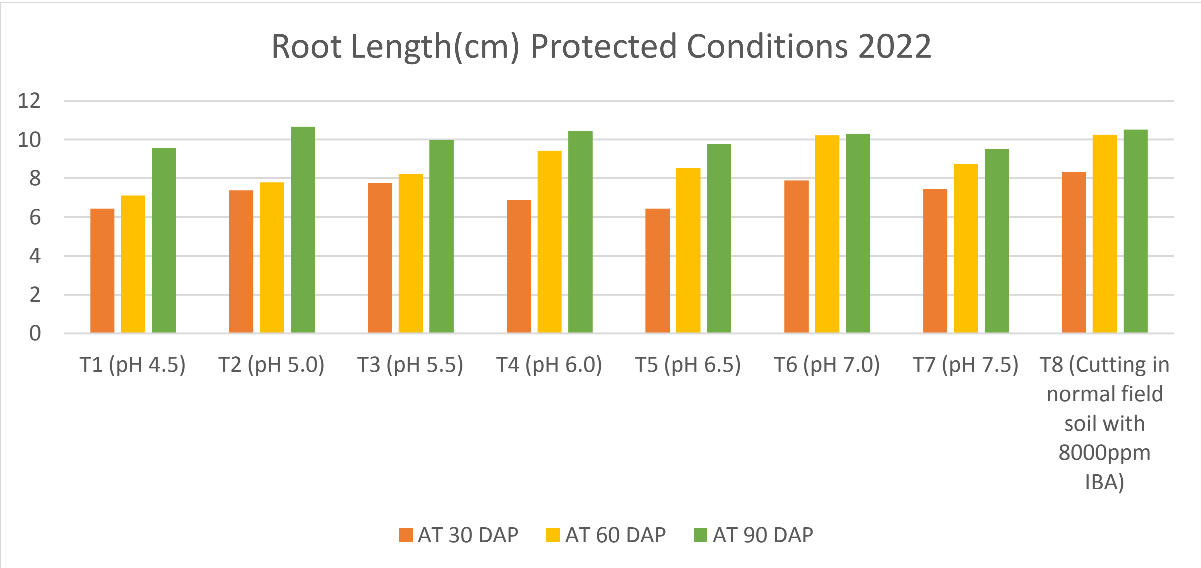
Graph 43 Per cent (%) Rooted pH Open Conditions 2021



Graph 44 Per cent (%) Rooted pH Protected Conditions 2021



Graph 45 Per cent (%) Rooted pH Open Conditions 2022



Graph 46 Per cent (%) Rooted pH Protected Conditions 2022

Tukey's test for Per cent (%) Rooted pH:

Groups		T1			T2			T3			T4		
		M.D	P-value	Status	M.D	P-Value	Status	M.D	P-Value	Status	M.D	P-Value	Status
G1	**G2**	-9.18	0.474	NS	-9.50	0.506	NS	-9.08	0.400	NS	-14.12	0.056	NS
	G3	-19.71	0.047	S	-20.02	0.062	NS	-19.00	0.034	S	-24.04	0.003	S
	G4	-33.57	0.002	S	-30.85	0.007	S	-28.45	0.004	S	-35.08	0.000	S
G2	**G1**	9.18	0.474	NS	9.50	0.506	NS	9.08	0.400	NS	14.12	0.056	NS
	G3	-10.53	0.368	NS	-10.51	0.428	NS	-9.91	0.333	NS	-9.92	0.205	NS
	G4	-24.39	0.016	S	-21.34	0.046	S	-19.36	0.031	S	-20.96	0.007	S
G3	**G1**	19.71	0.047	S	20.02	0.062	NS	19.00	0.034	S	24.04	0.003	S
	G2	10.53	0.368	NS	10.51	0.428	NS	9.91	0.333	NS	9.92	0.205	NS
	G4	-13.86	0.182	NS	-10.83	0.405	NS	-9.45	0.369	NS	-11.04	0.146	NS
G4	**G1**	33.57	0.002	S	30.85	0.007	S	28.45	0.004	S	35.08	0.000	S
	G2	24.39	0.016	S	21.34	0.046	S	19.36	0.031	S	20.96	0.007	S
	G3	13.86	0.182	NS	10.83	0.405	NS	9.45	0.369	NS	11.04	0.146	NS

Table 42 Tukey's test for Per cent (%) Rooted pH T1-T4

For treatment 1 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.047 ,0.002, 0.016, and mean difference -19.71, -33.57, -24.39, 19.71, 33.57 and 24.39 on the other hand the remaining group doesn't have significant difference.

For treatment 2 there is a significant difference between G1(Open 2021) - G4(Protected 2022) , G2(Protected 2021) – G4(Protected 2022), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) with significant values 0.007, 0.046 and with mean difference of -21.34, -30.85, 30.85, 21.34 on the other hand the remaining group doesn't have significant difference.

For treatment 3 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.034 ,0.004, 0.031, and mean difference -19.00, -28.45, -19.36, 19.00, 28.45 and 19.36 on the other hand the remaining group doesn't have significant difference.

For treatment 4 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.003 ,0.000, 0.00\7, and mean difference -22.04, -32.00, -20.96, 22.04, 32.00 and 20.96 on the other hand the remaining group doesn't have significant difference.

Groups		T5			T6			T7			T8		
		M.D	P-value	Status	M.D	P-Value	Status	M.D	P-Value	Status	M.D	P-Value	Status
G1	G2	-7.39	0.085	NS	-9.71	0.663	NS	-9.62	0.535	NS	-10.61	0.351	NS
	G3	-18.35	0.193	NS	-16.80	0.258	NS	-17.47	0.128	NS	-22.05	0.026	S
	G4	-28.62	0.034	S	-34.52	0.014	S	-27.55	0.017	S	-33.00	0.003	S
G2	G1	7.39	0.805	NS	9.71	0.663	NS	9.62	0.535	NS	10.61	0.351	NS
	G3	-10.95	0.568	NS	-7.09	0.829	NS	-7.85	0.678	NS	-11.43	0.297	NS
	G4	-21.22	0.119	NS	-24.81	0.069	NS	-17.93	0.117	NS	-22.38	0.024	S
G3	G1	18.35	0.193	NS	16.80	0.258	NS	17.47	0.128	NS	22.05	0.026	S
	G2	10.95	0.568	NS	7.09	0.829	NS	7.85	0.678	NS	11.43	0.297	NS
	G4	-10.26	0.615	NS	-17.72	0.223	NS	-10.08	0.500	NS	-10.95	0.328	NS
G4	G1	28.62	0.034	S	34.52	0.014	S	27.55	0.017	S	33.00	0.003	S
	G2	21.22	0.119	NS	24.81	0.069	NS	17.93	0.117	NS	22.38	0.024	S
	G3	10.26	0.615	NS	17.72	0.223	NS	10.08	0.500	NS	10.95	0.328	NS

Table 43 Tukey's test for Per cent (%) Rooted pH T5-T8

For treatment 5 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.034 and with mean difference of -28.62, 28.62 on the other hand the remaining group doesn’t have significant difference.

For treatment 6 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.014 and with mean difference of -34.52, 34.52 on the other hand the remaining group doesn't have significant difference.

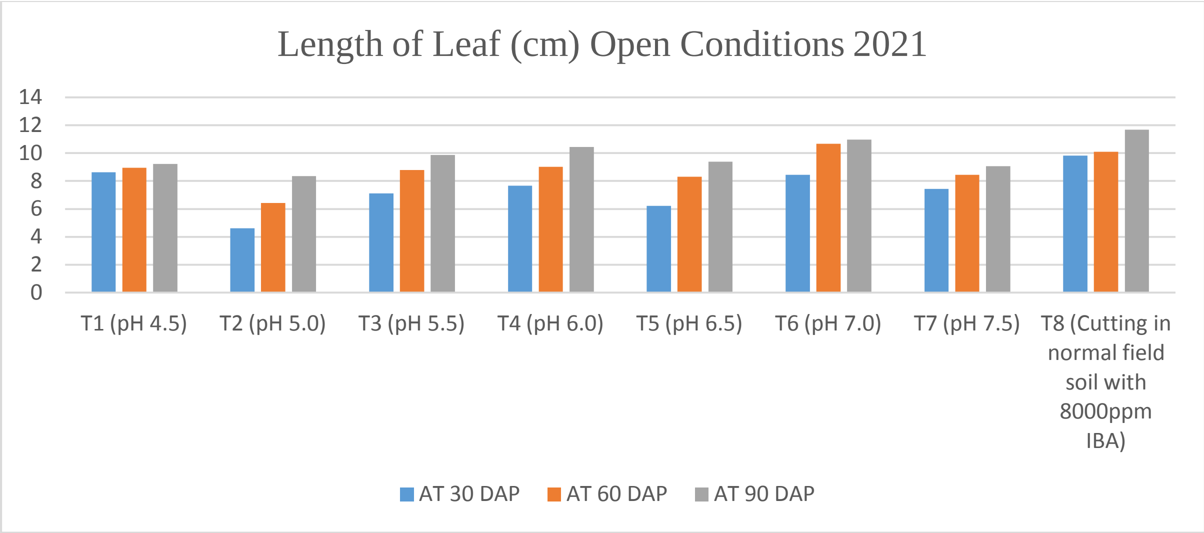
For treatment 7 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.017 and with mean difference of -27.55, 27.55 on the other hand the remaining group doesn't have significant difference.

For treatment 8 there is a significant difference between G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) – G4(Protected 2022), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) with significant values 0.026, 0.003, 0.024 and with mean difference of -22.05, -33.00, -22.38, 22.05, 33.00, and 22.38 on the other hand the remaining group doesn't have significant difference.

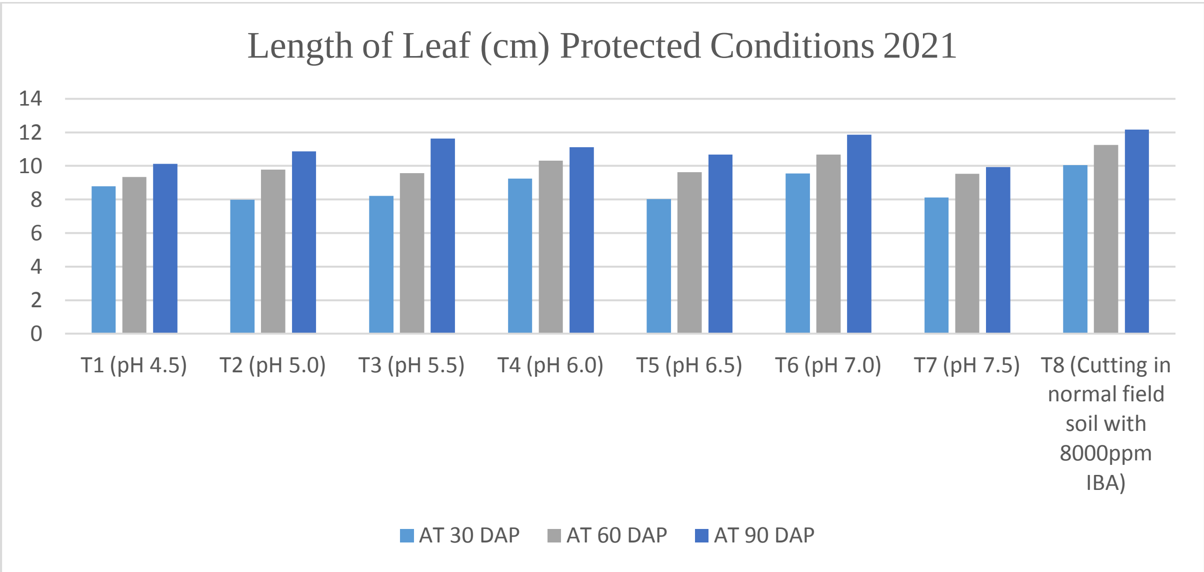
8.16: Impact of different growing media pH on Length of Leaf of Cutting in Guava (*Psidium guajava* L.):

Treatment Symbol	2021								2022							
	Length of Leaf (cm)								Length of Leaf (cm)							
	Open Conditions				Protected Conditions				Open Conditions				Protected Conditions			
	At 30DAP	**AT 60 DAP**	**AT 90 DAP**	**Mean**	**At 30DAP**	**AT 60 DAP**	**AT 90 DAP**	**Mean**	**At 30DAP**	**AT 60 DAP**	**AT 90 DAP**	**Mean**	**At 30DAP**	**AT 60 DAP**	**AT 90 DAP**	**Mean**
T1 (pH 4.5)	8.63	8.94	9.23	8.93	8.79	9.35	10.12	9.42	8.79	9.21	9.87	9.29	9.46	9.78	10.67	9.97
T2 (pH 5.0)	4.61	6.43	8.36	6.47	7.99	9.78	10.87	9.55	6.32	8.56	8.95	7.94	7.45	9.34	10.66	9.15
T3 (pH 5.5)	7.12	8.78	9.86	8.59	8.21	9.57	11.64	9.81	7.01	8.23	9.14	8.13	8.60	9.01	10.78	9.46
T4 (pH 6.0)	7.67	9.01	10.45	9.04	9.24	10.32	11.12	10.23	7.01	8.15	8.24	7.80	8.57	9.88	11.12	9.86
T5 (pH 6.5)	6.23	8.30	9.38	7.97	8.02	9.63	10.67	9.44	8.12	8.57	9.36	8.68	9.03	9.98	10.76	9.92
T6 (pH 7.0)	8.45	10.67	10.96	10.03	9.56	10.67	11.86	10.70	9.26	11.17	10.12	10.18	10.13	10.77	11.03	10.64
T7 (pH 7.5)	7.43	8.45	9.07	8.32	8.12	9.53	9.94	9.20	6.79	9.01	9.67	8.49	8.80	9.60	10.34	9.58
T8 (Soil with 8000ppm IBA)	9.83	10.10	11.68	10.54	10.04	11.24	12.17	11.15	9.42	10.47	11.12	10.34	10.67	11.02	11.89	11.19
Mean	7.50	8.84	9.87	8.74	8.75	10.01	11.05	9.94	7.84	9.17	9.56	8.86	9.09	9.92	10.91	9.97
CD **at 5%**	**1.04**	**0.85**	**0.66**	**0.81**	**0.41**	**0.38**	**0.45**	**0.39**	**0.62**	**0.60**	**0.58**	**0.51**	**0.64**	**0.40**	**0.31**	**0.44**

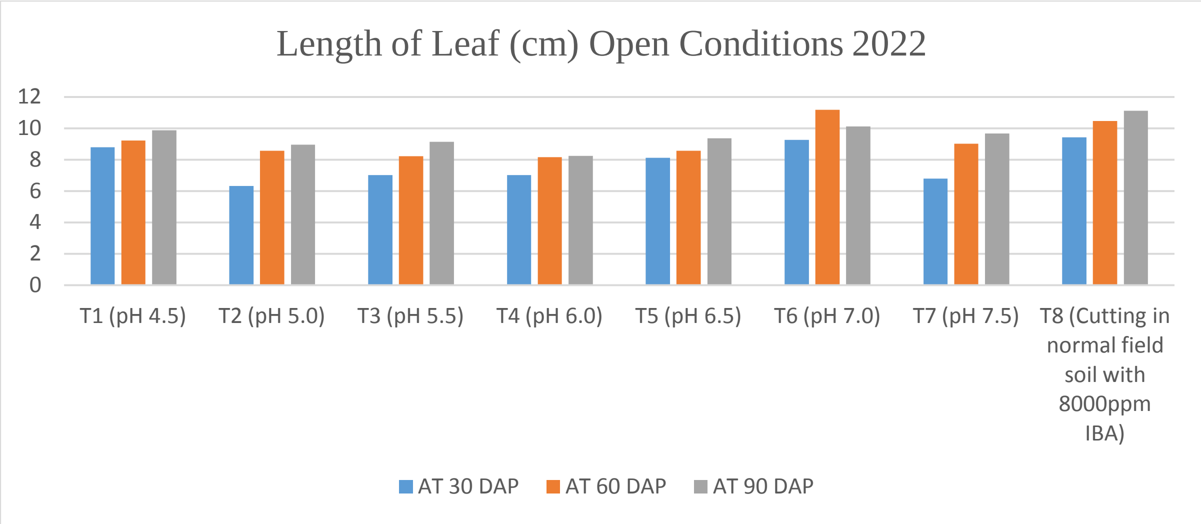
Table 44 Length of Leaf pH



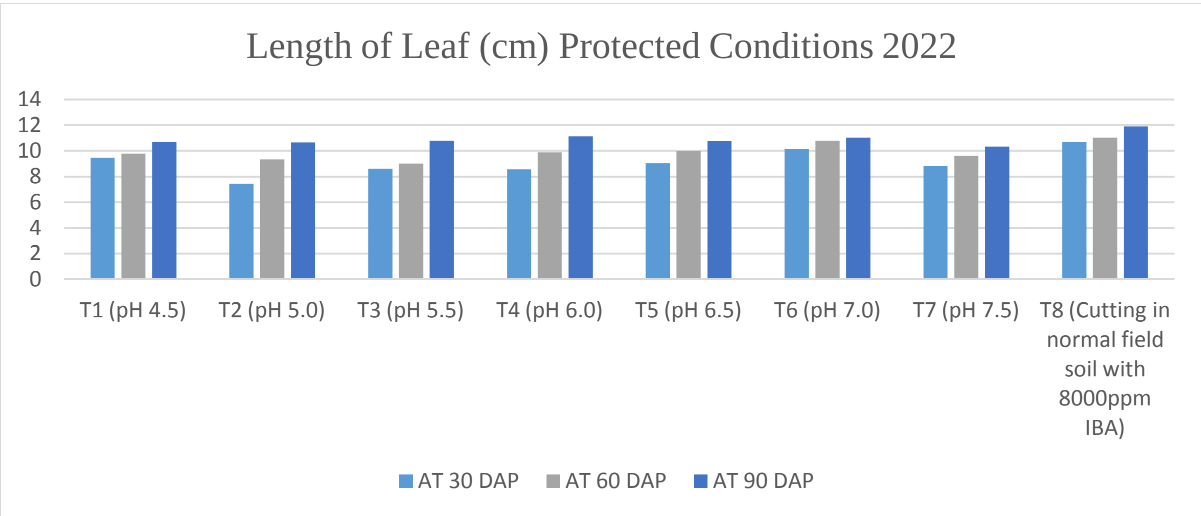
Graph 47 Length of Leaf Open Conditions 2021



Graph 48 Length of Leaf Protected Conditions 2021



Graph 49 Length of Leaf Open Conditions 2022



Graph 50 Length of Leaf Protected Conditions 2022

Tukey's test for Length of Leaf pH:

Groups		T1			T2			T3			T4		
		M.D	P-value	Status	M.D	P-Value	Status	M.D	P-Value	Status	M.D	P-Value	Status
G1	G2	-7.15	0.474	NS	-9.50	0.506	NS	-9.05	0.400	NS	-14.12	0.056	NS
	G3	-13.71	0.047	S	-20.02	0.062	NS	-19.00	0.024	S	-24.04	0.002	S
	G4	-22.57	0.002	S	-20.55	0.007	S	-25.45	0.004	S	-25.05	0.000	S
G2	G1	7.15	0.474	NS	9.50	0.506	NS	9.05	0.400	NS	14.12	0.056	NS
	G3	-10.52	0.265	NS	-10.51	0.425	NS	-9.91	0.222	NS	-9.92	0.205	NS
	G4	-24.29	0.016	S	-21.24	0.046	S	-19.26	0.021	S	-20.96	0.007	S
G3	G1	19.71	0.047	S	20.02	0.062	NS	19.00	0.024	S	24.04	0.002	S
	G2	10.52	0.265	NS	10.51	0.425	NS	9.91	0.222	NS	9.92	0.205	NS
	G4	-12.56	0.152	NS	-10.52	0.405	NS	-9.45	0.269	NS	-11.04	0.146	NS
G4	G1	22.57	0.002	S	20.55	0.007	S	25.45	0.004	S	25.05	0.000	S
	G2	24.29	0.016	S	21.24	0.046	S	19.26	0.021	S	20.96	0.007	S
	G3	12.56	0.152	NS	10.52	0.405	NS	9.45	0.269	NS	11.04	0.146	NS

Table 45 Tukey's test for Length of Leaf pH T1-T4

For treatment 1 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.047 ,0.002, 0.016, and mean difference -13.71,

-22.57, -24.29, 19.71, 22.57 and 24.29 on the other hand the remaining group doesn't have significant difference.

For treatment 2 there is a significant difference between G1(Open 2021) - G4(Protected 2022) , G2(Protected 2021) – G4(Protected 2022), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) with significant values 0.007, 0.046 and with mean difference of -20.55, -21.24, 20.55, 21.24 on the other hand the remaining group doesn't have significant difference.

For treatment 3 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.034 ,0.004, 0.031, and mean difference -19.00, -25.45, -19.26, 19.00, 25.45 and 19.26 on the other hand the remaining group doesn't have significant difference.

For treatment 4 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.003 ,0.000, 0.00\7, and mean difference -24.04, -25.05, -20.96, 24.04, 25.05 and 20.96 on the other hand the remaining group doesn't have significant difference.

Groups		**T5**			**T6**			**T7**			**T8**		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-3.35	0.085	NS	-5.31	0.663	NS	-5.62	0.535	NS	-10.61	0.351	NS
	G3	-8.65	0.153	NS	-16.80	0.258	NS	-13.43	0.128	NS	-15.05	0.026	S
	G4	-15.34	0.034	S	-24.12	0.014	S	-23.55	0.013	S	-33.00	0.003	S
G2	**G1**	3.35	0.805	NS	5.31	0.663	NS	5.62	0.535	NS	10.61	0.351	NS
	G3	-10.55	0.568	NS	-3.05	0.825	NS	-3.85	0.638	NS	-11.43	0.253	NS

	G4	-21.15	0.115	NS	-24.81	0.065	NS	-13.53	0.113	NS	-15.38	0.024	S
G3	**G1**	8.65	0.153	NS	16.80	0.258	NS	13.43	0.128	NS	15.05	0.026	S
	G2	10.55	0.568	NS	3.05	0.825	NS	3.85	0.638	NS	11.43	0.253	NS
	G4	-10.26	0.615	NS	-13.32	0.153	NS	-10.08	0.500	NS	-10.55	0.328	NS
G4	**G1**	15.34	0.034	S	24.12	0.014	S	23.55	0.013	S	33.00	0.003	S
	G2	21.15	0.115	NS	24.81	0.065	NS	13.53	0.113	NS	15.38	0.024	S
	G3	10.26	0.615	NS	13.32	0.153	NS	10.08	0.500	NS	10.55	0.328	NS

Table 46 Tukey's test for Length of Leaf pH T5-T8

For treatment 5 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.034 and with mean difference of -15.34, 15.34 on the other hand the remaining group doesn’t have significant difference.

For treatment 6 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.014 and with mean difference of -24.12, 24.12 on the other hand the remaining group doesn’t have significant difference.

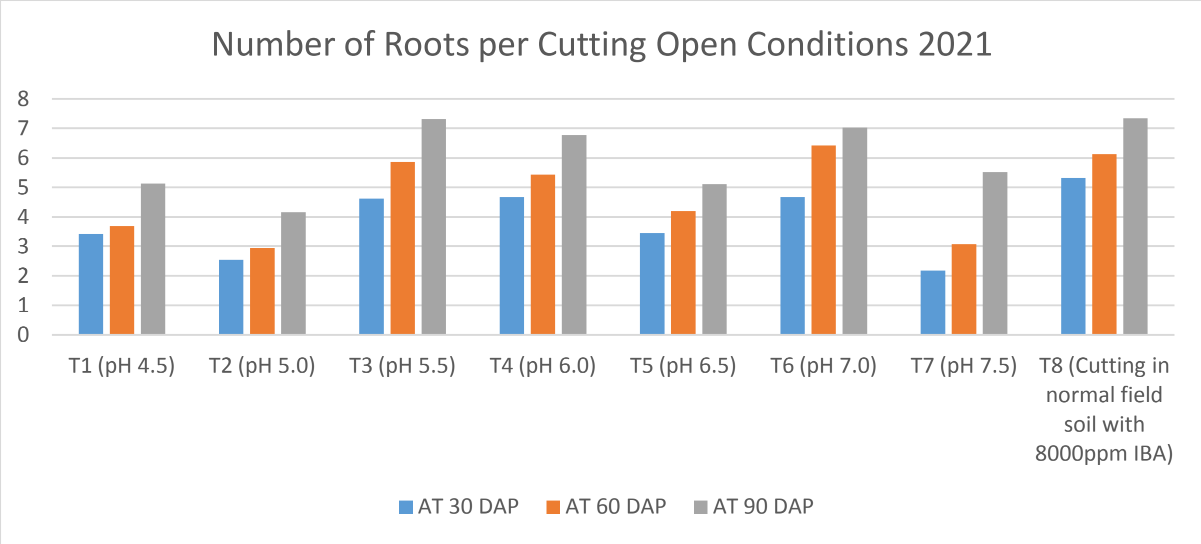
For treatment 7 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.017 and with mean difference of -23.55, 23.55 on the other hand the remaining group doesn’t have significant difference.

For treatment 8 there is a significant difference between G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) – G4(Protected 2022), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) with significant values 0.026, 0.003, 0.024 and with mean difference of -15.05, -33.00, -22.38, 15.05, 33.00, and 22.38 on the other hand the remaining group doesn’t have significant difference.

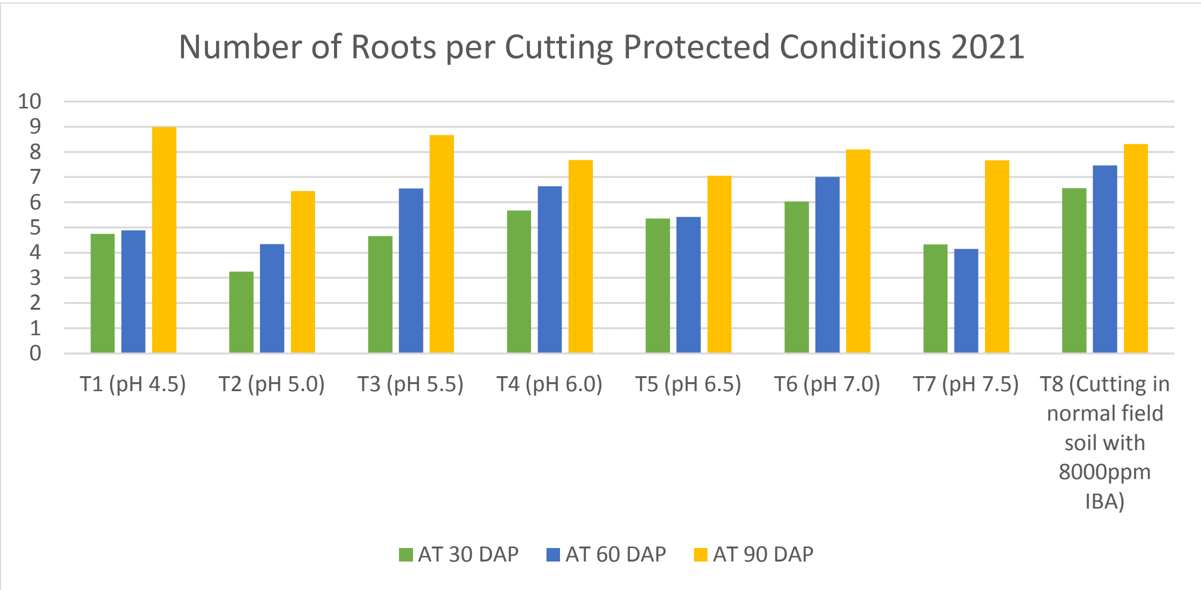
8.17: Impact of different growing media pH on Number of Roots Per Cutting of Cutting in Guava (*Psidium guajava* L.):

Treatment Symbol	2021								2022							
	Number of Roots Per Cutting								Number of Roots Per Cutting							
	Open Conditions				Protected Conditions				Open Conditions				Protected Conditions			
	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean
T1 (pH 4.5)	3.43	3.68	5.13	4.08	4.75	4.88	8.98	6.20	4.01	4.58	6.14	4.91	5.53	6.70	7.81	6.68
T2 (pH 5.0)	2.55	2.95	4.15	3.22	3.24	4.34	6.45	4.68	2.44	3.13	5.06	3.54	5.91	6.05	7.06	6.34
T3 (pH 5.5)	4.62	5.87	7.32	5.94	4.66	6.55	8.67	6.63	3.85	5.98	6.22	5.35	4.89	5.91	9.03	6.61
T4 (pH 6.0)	4.67	5.43	6.78	5.63	5.67	6.63	7.68	6.66	4.34	5.23	7.32	5.63	5.55	7.54	7.78	6.96
T5 (pH 6.5)	3.45	4.2	5.11	4.25	5.35	5.42	7.06	5.94	3.32	4.15	4.50	3.99	4.57	5.34	7.87	5.93
T6 (pH 7.0)	4.67	6.42	7.03	6.04	6.02	7.01	8.09	7.04	5.34	7.02	6.35	6.24	6.03	7.32	7.21	6.85
T7 (pH 7.5)	2.18	3.07	5.52	3.59	4.32	4.15	7.66	5.38	2.34	3.54	4.97	3.62	4.01	5.15	7.73	5.63
T8 (Cutting in normal field soil with 8000ppm IBA)	5.32	6.12	7.34	6.26	6.56	7.46	8.31	7.44	6.13	6.68	7.68	6.83	6.55	7.68	8.28	7.50
Mean	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67
CD **at 5%**	0.63	0.69	0.64	0.61	0.66	0.66	0.51	0.55	0.76	0.78	0.64	0.66	0.51	0.51	0.39	0.37

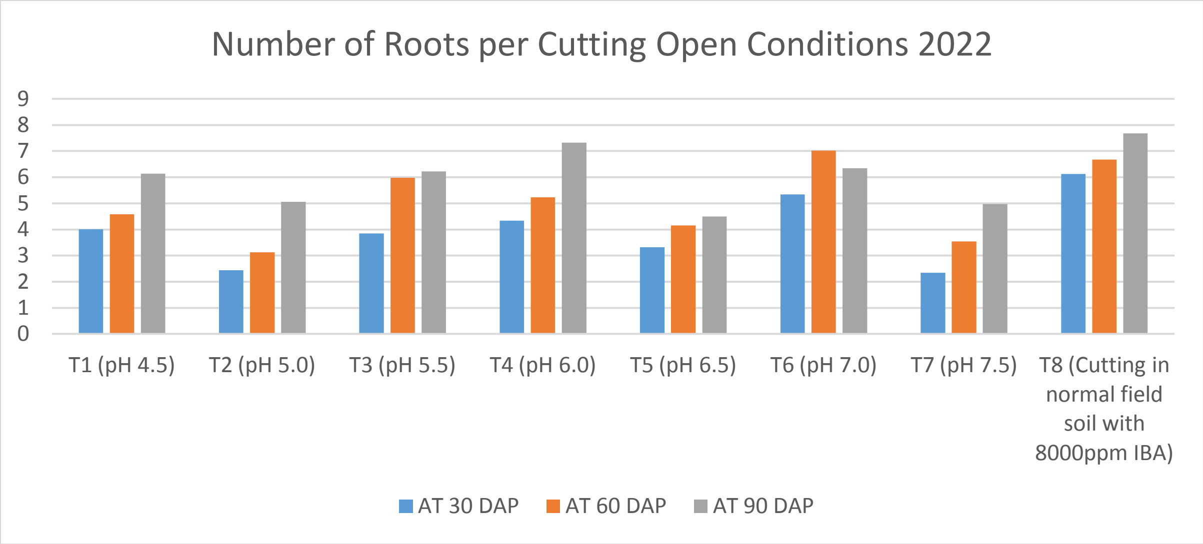
Table 47 Number of Roots Per Cutting pH



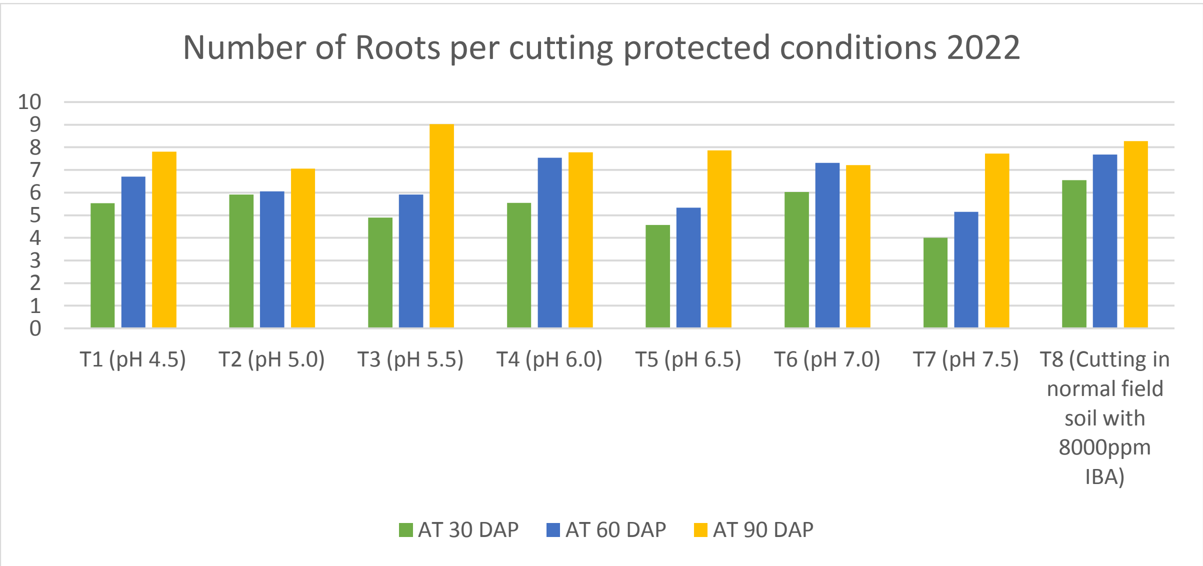
Graph 51 Number of Roots per Cutting pH Open Conditions 2021



Graph 52 Number of Roots per Cutting pH Protected Conditions 2021



Graph 53 Number of Roots per Cutting pH Open Conditions 2022



Graph 54 Number of Roots per Cutting pH Protected Conditions 2022

Tukey's test for Number of Roots Per Cutting pH:

Groups		T1			T2			T3			T4		
		M.D	P-value	Status	M.D	P-Value	Status	M.D	P-Value	Status	M.D	P-Value	Status
G1	**G2**	-11.46	0.242	NS	-7.90	0.702	NS	-9.64	0.615	NS	-10.15	0.367	NS
	G3	-23.05	0.014	S	-18.87	0.114	NS	-21.65	0.087	NS	-20.47	0.033	S
	G4	-32.93	0.002	S	-30.16	0.013	S	-31.99	0.014	S	-32.00	0.003	S
G2	**G1**	11.46	0.242	NS	7.90	0.702	NS	9.64	0.615	NS	10.15	0.367	NS
	G3	-11.58	0.235	NS	-10.97	0.469	NS	-12.00	0.451	NS	-10.31	0.355	NS
	G4	-21.47	0.020	S	-22.26	0.059	NS	-22.34	0.077	NS	-21.84	0.024	S
G3	**G1**	23.05	0.014	S	18.87	0.114	NS	21.65	0.087	NS	20.47	0.033	S
	G2	11.58	0.235	NS	10.97	0.469	NS	12.00	0.451	NS	10.31	0.355	NS
	G4	-9.88	0.347	NS	-11.29	0.446	NS	-10.34	0.565	NS	-11.53	0.274	NS
G4	**G1**	32.93	0.002	S	30.16	0.013	S	31.99	0.014	S	32.00	0.003	S
	G2	21.47	0.020	S	22.26	0.059	NS	22.34	0.077	NS	21.84	0.024	S
	G3	9.88	0.347	NS	11.29	0.446	NS	10.34	0.565	NS	11.53	0.274	NS

Table 48 Tukey's test for Number of Roots per Cutting pH T1-T4

For treatment 1 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.014 ,0.002, 0.020, and mean difference -23.05,

-32.93, -21.47, 23.05, 32.93 and 21.47 on the other hand the remaining group doesn't have significant difference.

For treatment 2 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.013 and with mean difference of -30.16, 30.16 on the other hand the remaining group doesn't have significant difference.

For treatment 3 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.014 and with mean difference of -31.99, 31.99 on the other hand the remaining group doesn't have significant difference.

For treatment 4 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.033 ,0.003, 0.024, and mean difference -20.47, -32.00, -21.84, 20.47, 32.00 and 21.84 on the other hand the remaining group doesn't have significant difference.

Groups		**T5**			**T6**			**T7**			**T8**		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-11.14	0.407	NS	-9.74	0.669	NS	-10.13	0.602	NS	-11.43	0.375	NS
	G3	-22.23	0.044	S	-21.79	0.120	NS	-21.36	0.103	NS	-22.41	0.040	S
	G4	-33.29	0.005	S	-31.90	0.022	S	-35.03	0.010	S	-32.87	0.005	S
G2	**G1**	11.14	0.407	NS	9.74	0.669	NS	10.13	0.602	NS	11.43	0.375	NS
	G3	-11.08	0.411	NS	-12.05	0.517	NS	-11.23	0.526	NS	-10.98	0.407	NS
	G4	-22.15	0.045	S	-22.16	0.112	NS	-24.90	0.055	NS	-21.43	0.049	S
G3	**G1**	22.23	0.0	S	21.79	0.1	NS	21.36	0.1	NS	22.41	0.0	S

			44			20			03			40	
	G2	11.08	0.4 11	NS	12.05	0.5 17	NS	11.23	0.5 26	NS	10.98	0.4 07	NS
	G4	-11.06	0.4 12	NS	-10.11	0.6 44	NS	-13.67	0.3 74	NS	-10.45	0.4 45	NS
G4	**G1**	33.29	0.0 05	S	31.90	0.0 22	S	35.03	0.0 10	S	32.87	0.0 05	S
	G2	22.15	0.0 45	S	22.16	0.1 12	NS	24.90	0.0 55	NS	21.43	0.0 49	S
	G3	11.06	0.4 12	NS	10.11	0.6 44	NS	13.67	0.3 74	NS	10.45	0.4 45	NS

Table 49 Tukey's test for Number of Roots per Cutting pH T5-T8

For treatment 5 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.044 ,0.005, 0.045, and mean difference -22.23, -33.29, -22.15, 22.23, 33.29 and 22.15 on the other hand the remaining group doesn't have significant difference.

For treatment 6 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.022 and with mean difference of -31.90, 31.90 on the other hand the remaining group doesn't have significant difference.

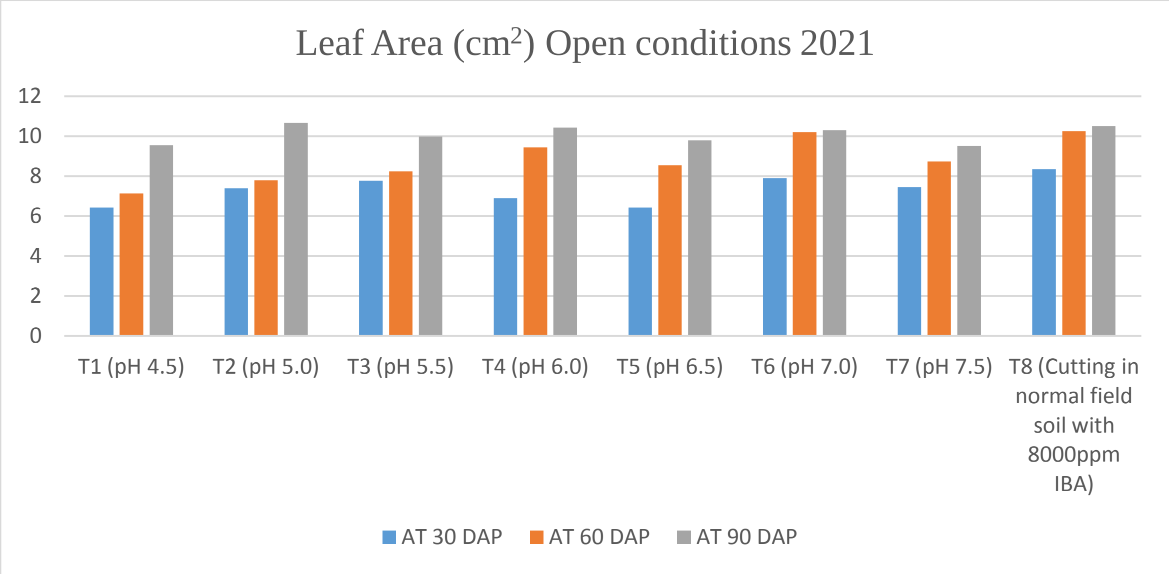
For treatment 7 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.010 and with mean difference of -35.03, 35.03 on the other hand the remaining group doesn't have significant difference.

For treatment 8 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.040 ,0.005, 0.049, and mean difference -20.41, -32.87, -21.43, 20.41, 32.87 and 21.41 on the other hand the remaining group doesn't have significant difference.

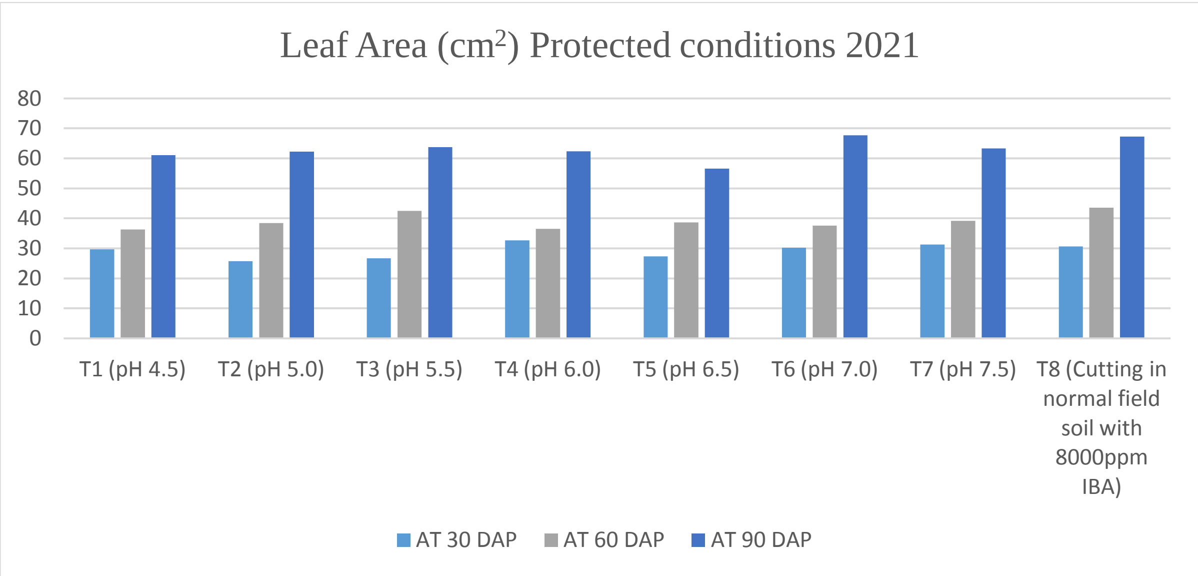
8.18: Impact of different growing media pH on Leaf Area of Cutting in Guava (*Psidium guajava* L.):

Treatment Symbol	2021								2022							
	Leaf Area (cm^2)								Leaf Area (cm^2)							
	Open Conditions				Protected Conditions				Open Conditions				Protected Conditions			
	At 30DAP	AT 60 DAP	AT 60 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean
T1 (pH 4.5)	27.66	33.21	39.46	33.44	29.63	36.34	61.03	42.33	29.22	32.92	27.87	30.00	32.22	38.83	69.67	46.91
T2 (pH 5.0)	25.32	33.76	43.22	34.10	25.72	38.45	62.23	42.13	27.98	31.43	44.43	34.61	28.49	41.11	66.78	45.46
T3 (pH 5.5)	27.56	35.43	48.45	37.15	26.72	42.45	63.76	44.31	24.74	37.34	42.21	34.76	27.48	45.47	65.78	46.24
T4 (pH 6.0)	26.21	32.66	46.56	35.14	32.71	36.52	62.31	43.85	23.62	30.92	44.58	33.04	34.82	39.38	67.47	47.22
T5 (pH 6.5)	25.56	32.12	42.44	33.37	27.33	38.64	56.54	40.84	26.46	30.32	48.67	35.15	31.79	42.73	63.57	46.03
T6 (pH 7.0)	26.21	32.26	53.87	37.45	30.22	37.62	67.67	45.17	27.32	31.74	49.67	36.24	31.74	41.84	69.36	47.65
T7 (pH 7.5)	25.76	36.01	47.34	36.37	31.31	39.23	63.33	44.62	24.49	34.48	46.67	35.21	31.29	43.58	64.34	46.40
T8 (Soil with 8000ppm IBA)	25.30	33.73	53.45	37.49	30.66	43.55	67.22	47.14	28.23	35.12	52.39	38.58	38.83	45.79	65.74	50.12
Mean	26.20	33.65	46.85	35.56	29.29	39.10	63.01	43.80	26.51	33.03	44.56	34.70	32.08	42.34	66.59	47.00
CD **at 5%**	0.47	0.78	2.88	0.82	1.40	1.44	2.23	1.26	1.12	1.40	4.90	1.72	2.27	1.39	1.22	0.93

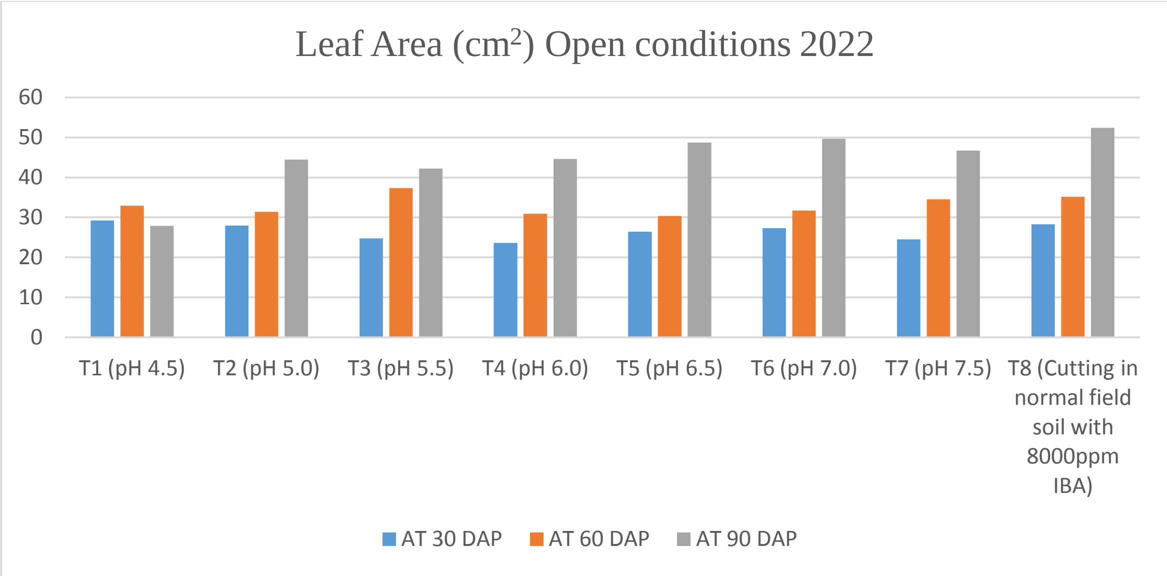
Table 50 Leaf Area pH



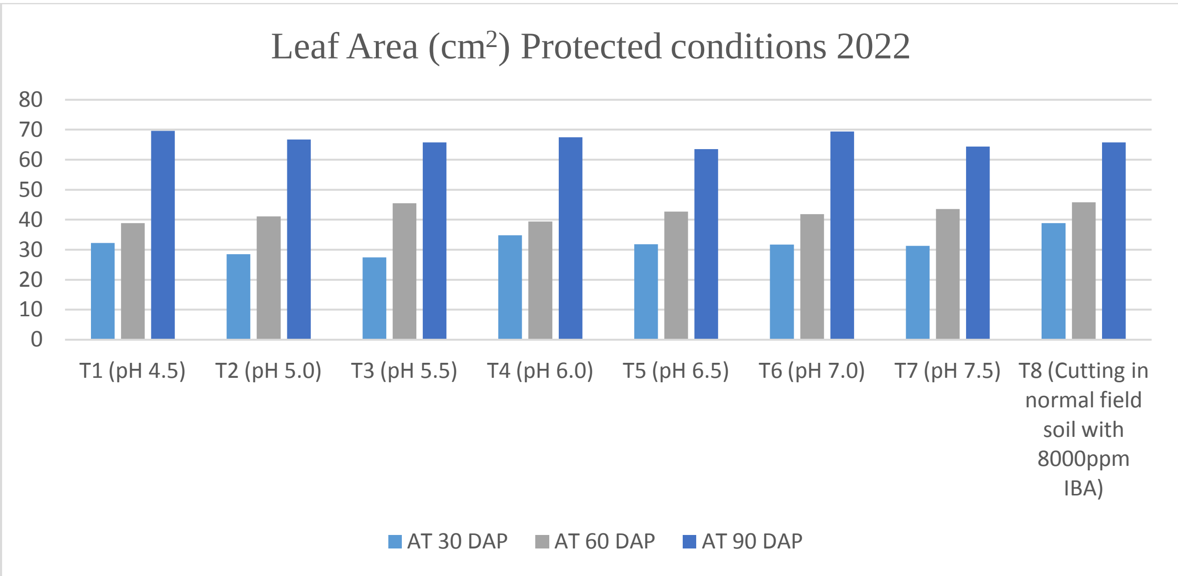
Graph 55 Leaf Area (cm^2) pH Open conditions 2021



Graph 56 Leaf Area (cm^2) pH Protected conditions 2021



Graph 57 Leaf Area (cm^2) pH Open conditions 2022



Graph 58 Leaf Area (cm^2) pH Protected conditions 2022

Tukey's test for Leaf Area

Groups		T1			T2			T3			T4		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-13.03	0.222	NS	-6.73	0.313	NS	-13.32	0.226	NS	-13.03	0.226	NS
	G3	-21.32	0.033	NS	-16.33	0.030	NS	-22.07	0.061	NS	-22.13	0.033	NS
	G4	-32.62	0.007	S	-31.36	0.007	S	-33.32	0.007	S	-33.22	0.007	S
G2	**G1**	13.03	0.222	NS	6.73	0.313	NS	-13.32	0.226	NS	13.03	0.226	NS
	G3	-7.76	0.267	NS	-6.73	0.312	NS	-7.73	0.236	NS	-13.06	0.227	NS
	G4	-21.36	0.033	NS	-21.62	0.031	NS	-22.22	0.060	NS	-21.12	0.033	NS
G3	**G1**	21.32	0.033	NS	16.33	0.030	NS	22.07	0.061	NS	22.13	0.033	NS
	G2	7.76	0.267	NS	6.73	0.312	NS	7.73	0.236	NS	13.06	0.227	NS
	G4	-13.7	0.223	NS	-13.36	0.363	NS	-13.26	0.236	NS	-13.07	0.226	NS
G4	**G1**	32.62	0.007	S	31.36	0.007	S	33.32	0.007	S	33.22	0.007	S
	G2	21.36	0.033	NS	21.62	0.031	NS	22.22	0.060	NS	22.12	0.033	NS
	G3	13.7	0.223	NS	13.36	0.363	NS	13.26	0.236	NS	13.07	0.226	NS

Table 51 Tukey's test for Leaf Area pH T1-T4

For treatment 1 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.007 and with mean difference of -32.62, 32.62 on the other hand the remaining group doesn't have significant difference.

For treatment 2 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.007 and with mean difference of -31.36, 31.36 on the other hand the remaining group doesn't have significant difference.

For treatment 3 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.007 and with mean difference of -33.32, 33.32 on the other hand the remaining group doesn't have significant difference.

For treatment 4 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.007 and with mean difference of -33.22, 33.22 on the other hand the remaining group doesn't have significant difference.

Groups		**T5**			**T6**			**T7**			**T8**		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-3.53	0.612	NS	-8.53	0.322	NS	-8.25	0.332	NS	-3.23	0.251	NS
	G3	-13.63	0.035	NS	-21.22	0.023	S	-23.65	0.022	S	-13.53	0.033	S
	G4	-31.8	0.003	S	-32.13	0.003	S	-36.23	0.002	S	-30.22	0.003	S
G2	**G1**	3.53	0.612	NS	8.53	0.322	NS	8.25	0.332	NS	3.23	0.251	NS
	G3	-8.35	0.222	NS	-8.23	0.323	NS	-13.21	0.201	NS	-11.02	0.253	NS
	G4	-22.35	0.023	S	-21.20	0.025	S	-26.13	0.023	S	-21.36	0.013	S
G3	**G1**	13.63	0.035	NS	21.22	0.023	S	23.65	0.022	S	13.53	0.033	S
	G2	8.35	0.222	NS	8.23	0.323	NS	13.21	0.201	NS	11.02	0.253	NS
	G4	-11.22	0.211	NS	-8.35	0.312	NS	-12.56	0.305	NS	-8.31	0.231	NS

G4	**G1**	31.8	0.003	S	32.13	0.003	S	36.23	0.002	S	30.22	0.003	S
	G2	22.35	0.023	S	21.20	0.025	S	26.13	0.023	S	21.36	0.013	S
	G3	11.22	0.211	NS	8.35	0.312	NS	12.56	0.305	NS	8.31	0.231	NS

Table 52 Tukey's test for Leaf Area pH T5-T8

For treatment 5 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.003 and with mean difference of -31.8, 31.8 on the other hand the remaining group doesn't have significant difference.

For treatment 6 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.023 ,0.003, 0.025 and mean difference -21.22, -32.13, -21.20, 21.22, 32.13 and 21.20 on the other hand the remaining group doesn't have significant difference.

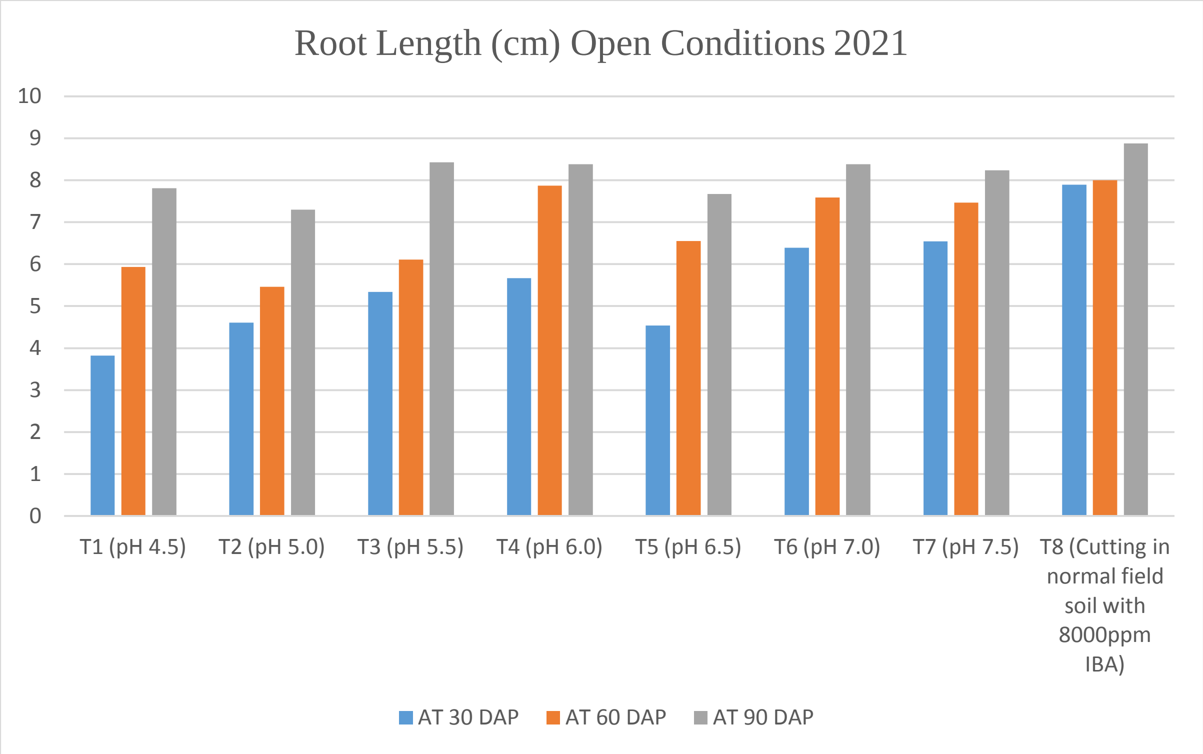
For treatment 7 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.022 ,0.004, 0.023 and mean difference -23.65, -36.23, -26.13, 23.65, 36.23 and 26.13 on the other hand the remaining group doesn't have significant difference.

For treatment 8 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.033 ,0.003, 0.018 and mean difference -30.22, -13.53, -21.36, 13.53, 30.22 and 21.36 on the other hand the remaining group doesn't have significant difference.

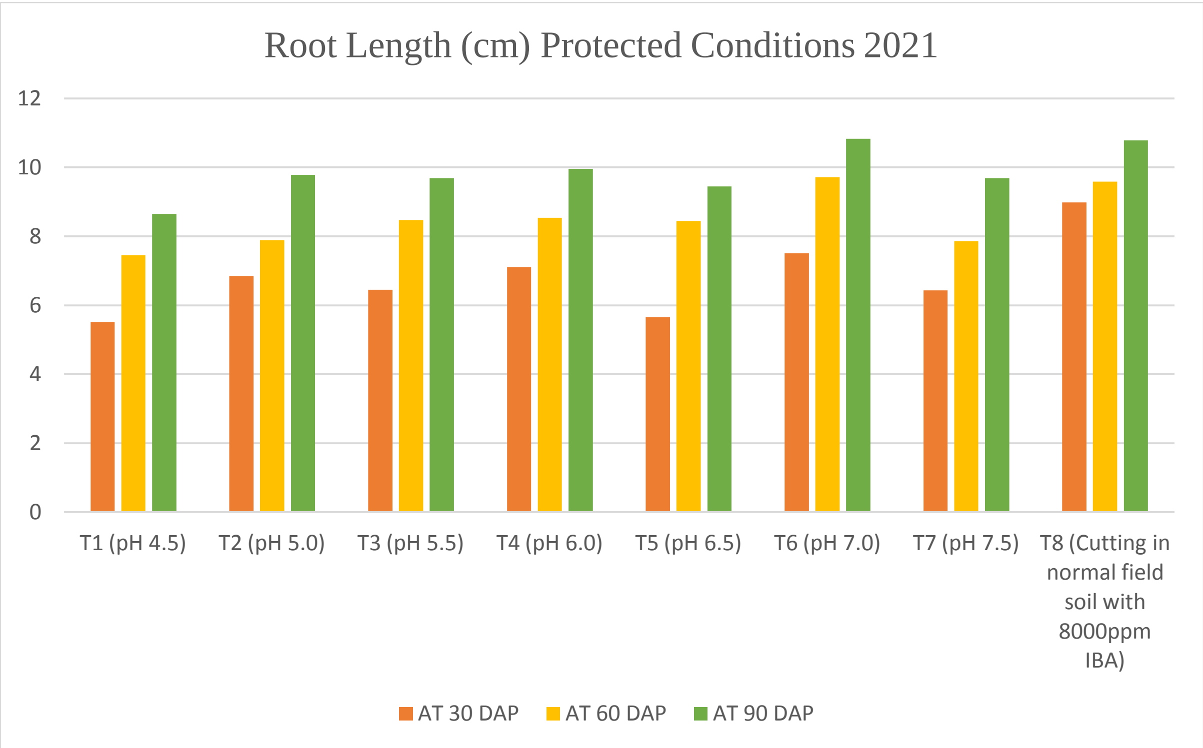
8.19: Impact of different growing media ph on Root Length (cm) of Cutting in Guava (*Psidium guajava* L.):

Treatment Symbol	2021								2022							
	Root Length(cm)								Root Length(cm)							
	Open Conditions				Protected Conditions				Open Conditions				Protected Conditions			
	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean
T1 (pH 4.5)	3.82	5.93	7.81	5.85	5.51	7.45	8.65	7.20	4.23	6.97	8.38	6.53	6.43	7.12	9.55	7.70
T2 (pH 5.0)	4.61	5.46	7.30	5.79	6.85	7.89	9.78	8.17	4.34	6.14	7.32	5.93	7.38	7.79	10.66	8.61
T3 (pH 5.5)	5.34	6.11	8.43	6.63	6.45	8.47	9.69	8.20	6.23	6.78	7.67	6.89	7.76	8.24	9.98	8.66
T4 (pH 6.0)	5.67	7.87	8.38	7.31	7.11	8.54	9.96	8.54	4.35	6.97	8.11	6.48	6.89	9.43	10.43	8.92
T5 (pH 6.5)	4.54	6.55	7.67	6.25	5.65	8.45	9.45	7.85	5.21	6.33	7.21	6.25	6.43	8.54	9.78	8.25
T6 (pH 7.0)	6.39	7.59	8.38	7.45	7.51	9.72	10.83	9.35	7.43	7.97	9.36	8.25	7.89	10.21	10.30	9.47
T7 (pH 7.5)	6.54	7.47	8.24	7.42	6.43	7.86	9.69	7.99	6.34	8.11	8.58	7.68	7.45	8.73	9.52	8.57
T8 (Soil with 8000ppm IBA)	7.89	8.00	8.88	8.26	8.98	9.59	10.78	9.78	8.29	8.67	9.23	8.73	8.34	10.25	10.51	9.70
Mean	5.60	6.87	8.14	6.87	6.81	8.50	9.85	8.39	5.80	7.24	8.23	7.09	7.32	8.79	10.09	8.73
CD **at 5%**	0.81	0.51	0.32	0.49	0.69	0.45	0.44	0.52	0.81	0.51	0.43	0.56	0.38	0.63	0.23	0.40

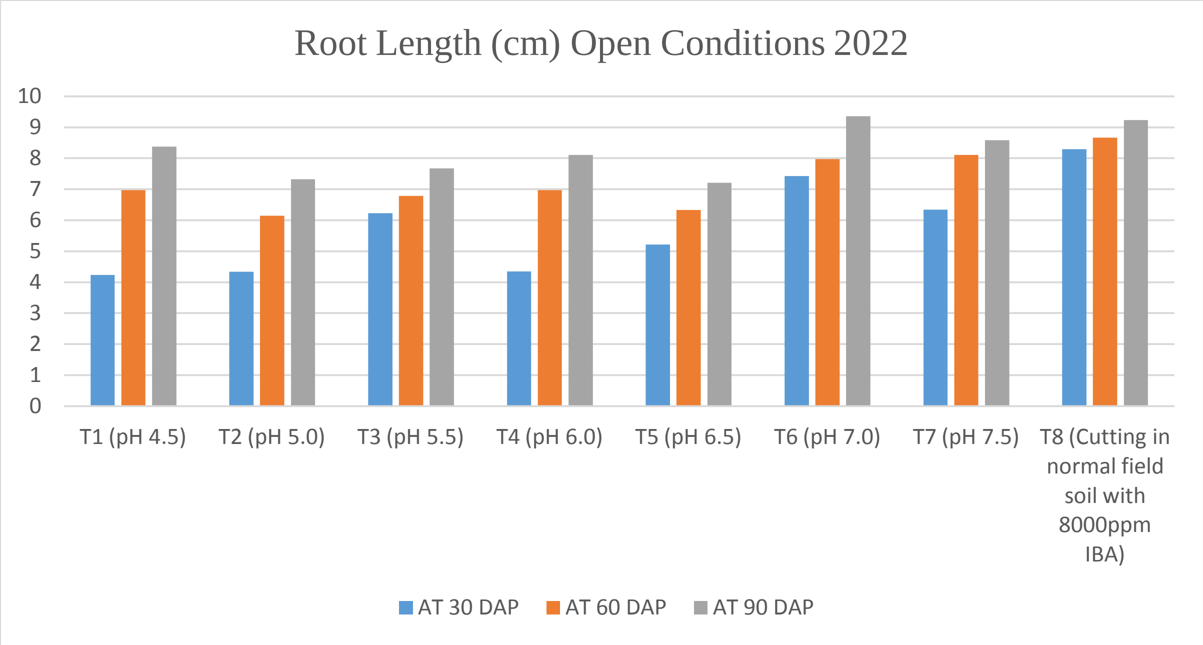
Table 53 Root Length pH



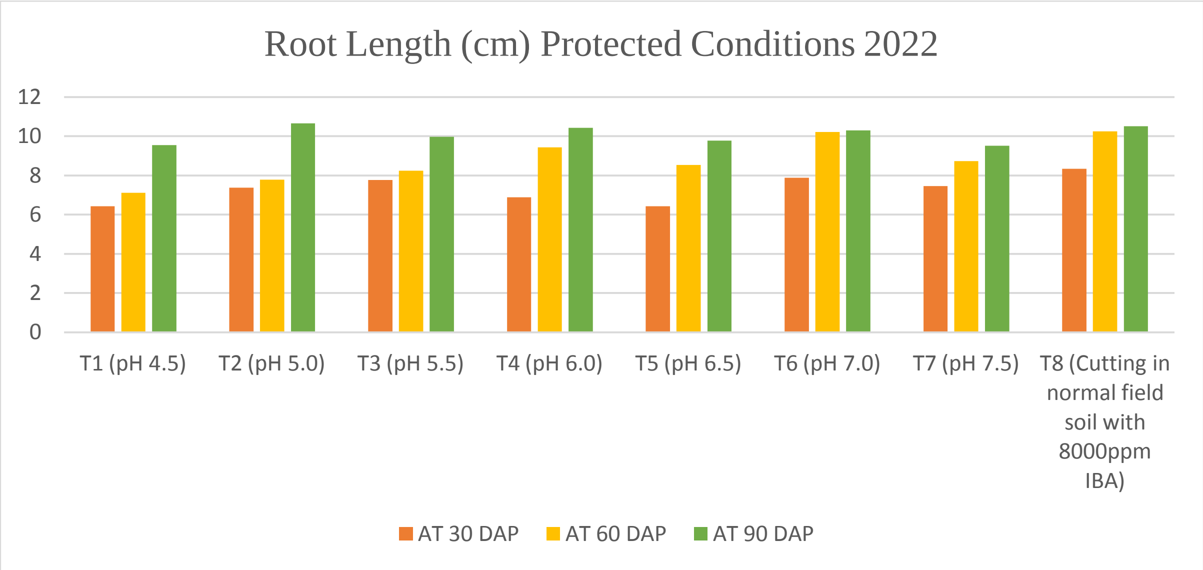
Graph 59 Root Length(cm) pH Open Conditions 2021



Graph 60 Root Length(cm) pH Protected Conditions 2021



Graph 61 Root Length pH Open Conditions 2022



Graph 62 Root Length pH Protected Conditions 2022

Tukey’s test for Root Length (cm):

Groups		T1			T2			T3			T4		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-10.60	0.536	NS	-9.27	0.358	NS	-10.51	0.545	NS	-11.23	0.492	NS
	G3	-18.41	0.150	NS	-21.38	0.016	S	-16.72	0.206	NS	-21.95	0.078	NS
	G4	-29.86	0.018	S	-33.98	0.001	S	-27.92	0.027	S	-32.51	0.012	S
G2	**G1**	10.60	0.536	NS	9.27	0.358	NS	10.51	0.545	NS	11.23	0.492	NS
	G3	-7.81	0.739	NS	-12.10	0.179	NS	-6.20	0.847	NS	-10.71	0.528	NS
	G4	-19.26	0.128	NS	-24.70	0.007	S	-17.40	0.182	NS	-21.28	0.089	NS
G3	**G1**	18.41	0.150	NS	21.38	0.016	S	16.72	0.206	NS	21.95	0.078	NS
	G2	7.81	0.739	NS	12.10	0.179	NS	6.20	0.847	NS	10.71	0.528	NS
	G4	-11.45	0.477	NS	-12.60	0.157	NS	-11.20	0.497	NS	-10.56	0.539	NS
G4	**G1**	29.86	0.018	S	33.98	0.001	S	27.92	0.027	S	32.51	0.012	S
	G2	19.26	0.128	NS	24.70	0.007	S	17.40	0.182	NS	21.28	0.089	NS
	G3	11.45	0.477	NS	12.60	0.157	NS	11.20	0.497	NS	10.56	0.539	NS

Table 54 Tukey's test for Root Length (cm) pH T1-T4

For treatment 1 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.018 and with mean difference of -29.86, 29.86 on the other hand the remaining group doesn’t have significant difference.

For treatment 2 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.016 ,0.001, 0.007, and mean difference -21.38, -33.98, -24.70, 21.38, 33.98 and 24.70 on the other hand the remaining group doesn't have significant difference.

For treatment 3 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.027 and with mean difference of -27.92, 27.92 on the other hand the remaining group doesn't have significant difference.

For treatment 4 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.012 and with mean difference of -32.51, 32.51 on the other hand the remaining group doesn't have significant difference.

Groups		**T5**			**T6**			**T7**			**T8**		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-11.03	0.488	NS	-11.11	0.388	NS	-10.21	0.346	NS	-10.97	0.201	NS
	G3	-22.05	0.070	NS	-22.23	0.039	S	-20.84	0.027	S	-21.82	0.010	S
	G4	-34.46	0.007	S	-31.66	0.006	S	-31.60	0.002	S	-32.42	0.001	S
G2	**G1**	11.03	0.488	NS	11.11	0.388	NS	10.21	0.346	NS	10.97	0.201	NS
	G3	-11.02	0.489	NS	-11.12	0.387	NS	-10.63	0.316	NS	-10.85	0.207	NS
	G4	-23.43	0.054	NS	-20.55	0.056	NS	-21.39	0.024	S	-21.45	0.011	S
G3	**G1**	22.05	0.070	NS	22.23	0.039	S	20.84	0.027	S	21.82	0.010	S
	G2	11.02	0.489	NS	11.12	0.387	NS	10.63	0.316	NS	10.85	0.207	NS

	G4	-12.41	0.397	NS	-9.43	0.514	NS	-10.76	0.307	NS	-10.60	0.222	NS
G4	**G1**	34.46	0.007	S	31.66	0.006	S	31.60	0.002	S	32.42	0.001	S
	G2	23.43	0.054	NS	20.55	0.056	NS	21.39	0.024	S	21.45	0.011	S
	G3	12.41	0.397	NS	9.43	0.514	NS	10.76	0.307	NS	10.60	0.222	NS

Table 55 Tukey's test for Root Length (cm) pH T5-T8

For treatment 5 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.007 and with mean difference of -34.46, 34.46 on the other hand the remaining group doesn't have significant difference.

For treatment 6 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), and G4(Protected 2022) - G1(Open 2021) With significant values 0.039 ,0.006, 0.039, and mean difference -22.23, -31.66, 22.23, and 31.66 on the other hand the remaining group doesn't have significant difference.

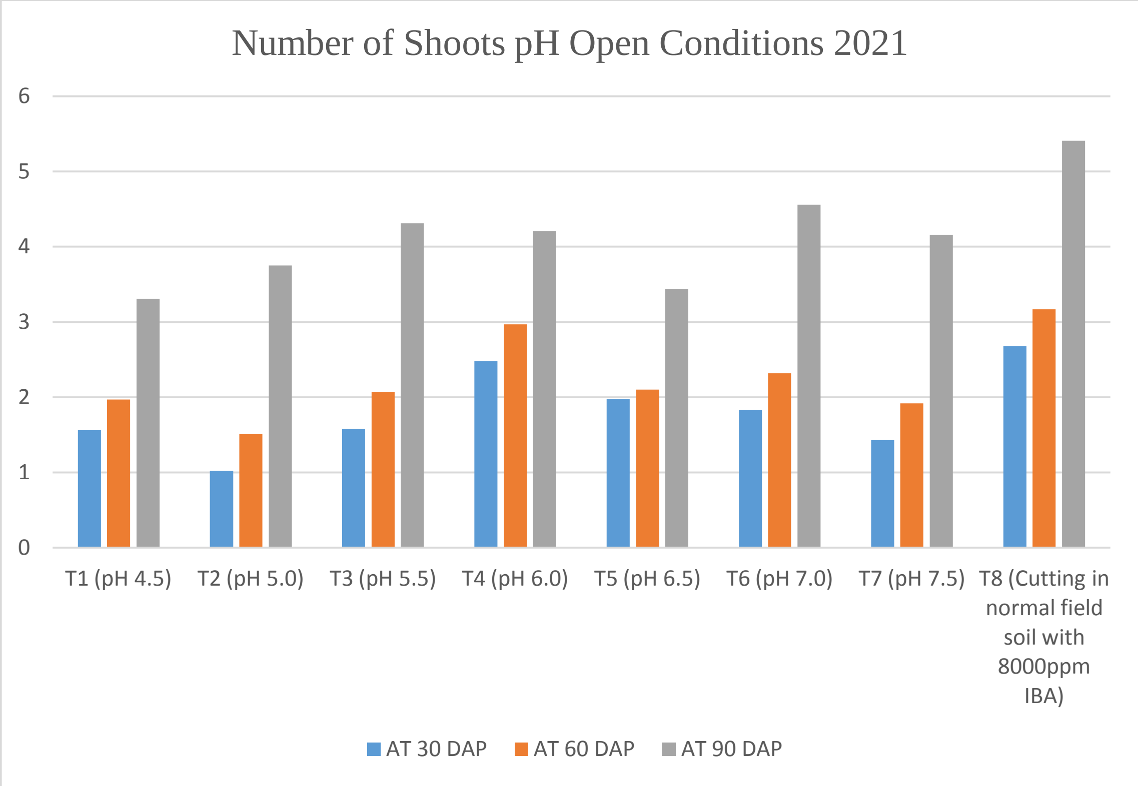
For treatment 7 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.027 ,0.002, 0.024, and mean difference -20.84, -31.60, -21.39, 20.84, 31.60 and 20.84 on the other hand the remaining group doesn't have significant difference.

For treatment 8 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.010 ,0.001, 0.011, and mean difference -21.82, -32.42, -21.45, 21.82, 32.42 and 21.45 on the other hand the remaining group doesn't have significant difference.

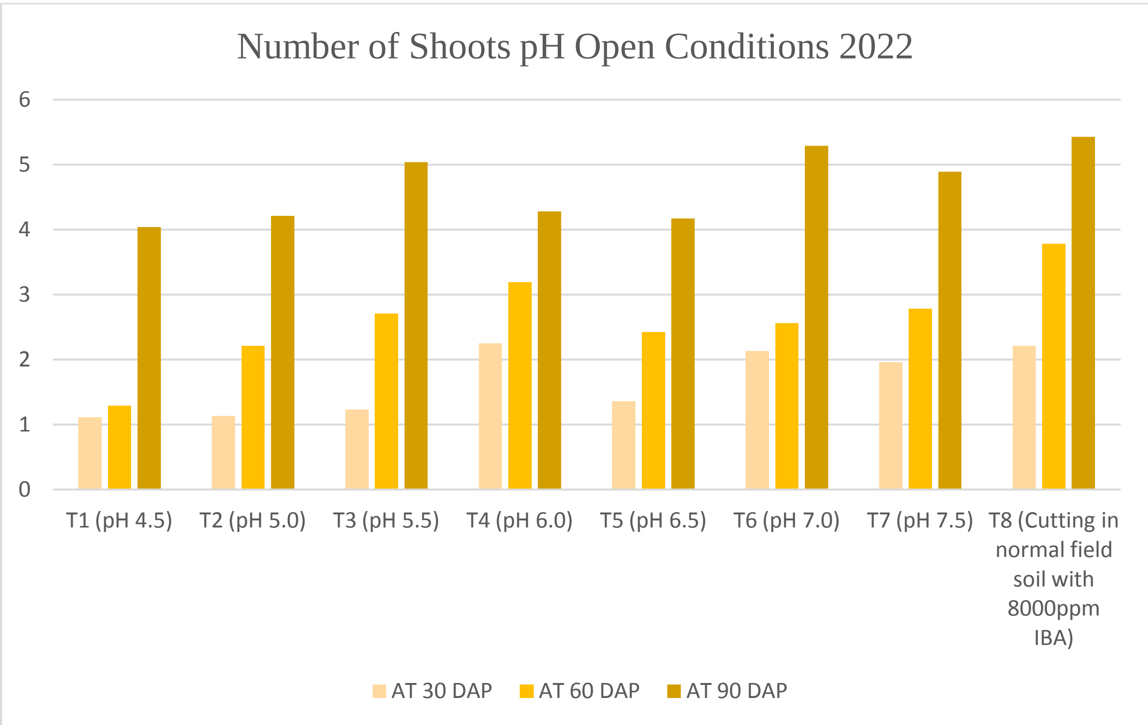
8.20: Impact of different growing media pH on Number of Shoots of Cutting in Guava (*Psidium guajava* L.):

Treatment Symbol	2021								2022							
	Number of Shoots								Number of Shoots							
	Open Conditions				Protected Conditions				Open Conditions				Protected Conditions			
	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean
T1 (pH 4.5)	1.56	1.97	3.31	2.28	1.95	2.59	4.38	2.97	1.11	1.29	4.04	2.15	1.98	3.49	5.16	3.54
T2 (pH 5.0)	1.02	1.51	3.75	2.09	1.62	2.29	4.82	2.91	1.13	2.21	4.21	2.52	1.68	3.93	4.60	3.40
T3 (pH 5.5)	1.58	2.07	4.31	2.65	2.18	2.63	5.38	3.40	1.23	2.71	5.04	2.99	1.98	2.89	6.16	3.68
T4 (pH 6.0)	2.48	2.97	4.21	3.22	2.88	3.11	4.67	3.55	2.25	3.19	4.28	3.24	3.26	3.88	5.06	4.07
T5 (pH 6.5)	1.98	2.10	3.44	2.51	2.01	2.68	4.51	3.07	1.36	2.42	4.17	2.65	2.68	3.62	5.29	3.86
T6 (pH 7.0)	1.83	2.32	4.56	2.90	2.43	2.54	5.63	3.53	2.13	2.56	5.29	3.33	2.80	3.53	6.32	4.22
T7 (pH 7.5)	1.43	1.92	4.16	2.50	2.03	2.17	5.23	3.14	1.96	2.78	4.89	3.21	2.40	3.17	5.64	3.74
T8 (Soil with 8000ppm IBA)	2.68	3.17	5.41	3.75	3.28	3.60	6.48	4.45	2.21	3.78	5.43	3.81	3.87	4.59	6.79	5.08
Mean	1.82	2.25	4.14	2.74	2.30	2.70	5.14	3.38	1.67	2.62	4.67	2.99	2.58	3.64	5.63	3.95
CD **at 5%**	0.33	0.37	0.42	0.36	0.45	0.30	0.41	0.31	0.24	0.50	0.28	0.36	0.44	0.33	0.44	0.34

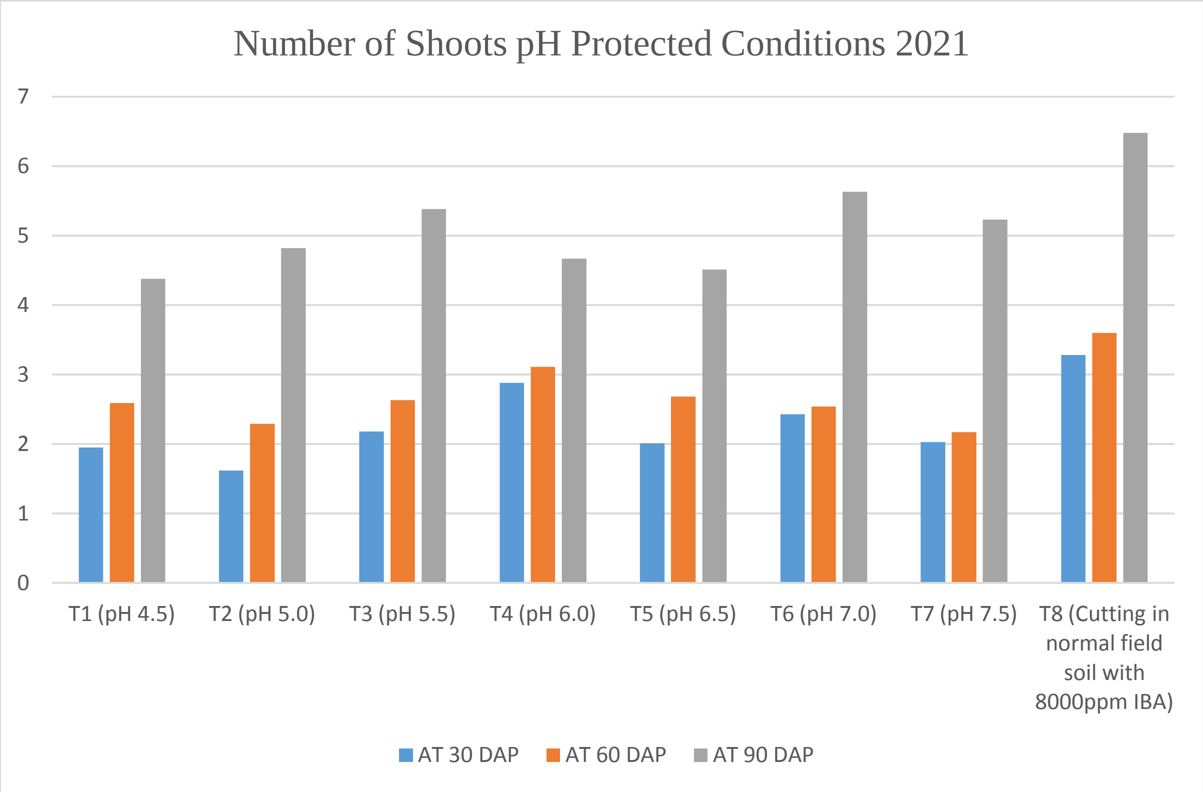
Table 56 Number of Shoots pH



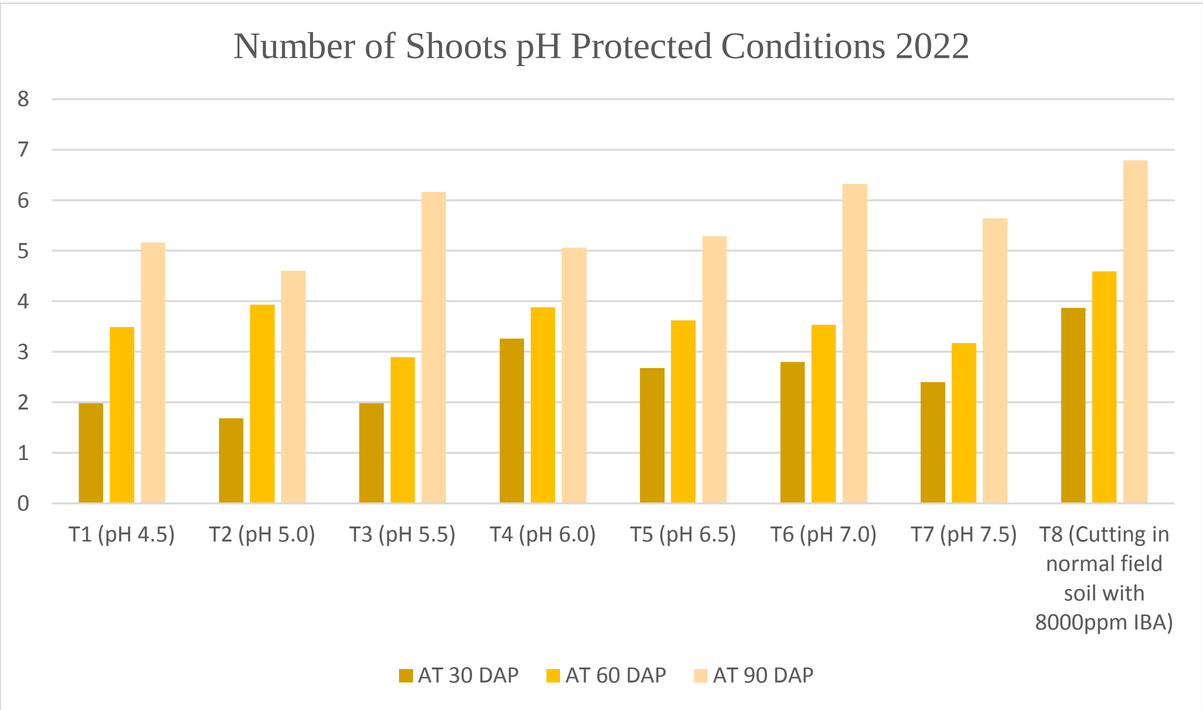
Graph 63 Number of Shoots pH Open Conditions 2021



Graph 64 Number of Shoots pH Protected Conditions 2021



Graph 65 Number of Shoots pH Open Conditions 2022



Graph 66 Number of Shoots pH Protected Conditions 2022

Tukey's test for Number of Shoots pH:

Groups		T1			T2			T3			T4		
		M.D	P-value	Status	M.D	P-Value	Status	M.D	P-Value	Status	M.D	P-Value	Status
G1	**G2**	-11.58	0.267	NS	-10.61	0.533	NS	-10.72	0.371	NS	-11.13	0.432	NS
	G3	-22.96	0.018	S	-18.61	0.143	NS	-21.04	0.039	S	-20.04	0.079	NS
	G4	-36.67	0.001	S	-29.22	0.020	S	-32.49	0.004	S	-31.25	0.009	S
G2	**G1**	11.58	0.267	NS	10.61	0.533	NS	10.72	0.371	NS	11.13	0.432	NS
	G3	-11.37	0.280	NS	-7.99	0.725	NS	-10.31	0.401	NS	-8.91	0.600	NS
	G4	-25.08	0.011	S	-18.61	0.143	NS	-21.77	0.033	S	-20.12	0.078	NS
G3	**G1**	22.96	0.018	S	18.61	0.143	NS	21.04	0.039	S	20.04	0.074	NS
	G2	11.37	0.280	NS	7.99	0.725	NS	10.31	0.401	NS	8.91	0.600	NS
	G4	-13.71	0.164	NS	-10.61	0.533	NS	-11.45	0.322	NS	-11.20	0.427	NS
G4	**G1**	36.67	0.001	S	29.22	0.020	S	32.49	0.004	S	31.25	0.009	S
	G2	25.08	0.011	S	18.61	0.143	NS	21.77	0.033	S	20.12	0.078	NS
	G3	13.71	0.164	NS	10.61	0.533	NS	11.45	0.322	NS	11.20	0.427	NS

Table 57 Tukey's test for Number of Shoots pH T1-T4

For treatment 1 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.018 ,0.001, 0.011, and mean difference -22.96,

-36.67, -25.08, 22.96, 36.67 and 25.08 on the other hand the remaining group doesn't have significant difference.

For treatment 2 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.020 and with mean difference of -29.22, 29.22 on the other hand the remaining group doesn't have significant difference.

For treatment 3 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.039 ,0.004, 0.011, and mean difference -21.04, -32.49, -21.77, 21.04, 32.49 and 21.77 on the other hand the remaining group doesn't have significant difference.

For treatment 4 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.009 and with mean difference of -31.25, 31.25 on the other hand the remaining group doesn't have significant difference.

Groups		**T5**			**T6**			**T7**			**T8**		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-10.50	0.360	NS	-11.10	0.510	NS	-11.44	0.537	NS	-11.44	0.395	NS
	G3	-20.77	0.035	S	-20.44	0.108	NS	-19.20	0.169	NS	-22.15	0.048	S
	G4	-31.75	0.003	S	-31.56	0.015	S	-29.64	0.028	S	-33.50	0.005	S
G2	**G1**	10.50	0.360	NS	11.10	0.510	NS	11.44	0.537	NS	11.44	0.395	NS
	G3	-10.27	0.376	NS	-9.34	0.636	NS	-7.76	0.783	NS	-10.71	0.447	NS
	G4	-21.25	0.031	S	-20.46	0.108	NS	-18.20	0.199	NS	-22.06	0.048	S
G3	**G1**	20.77	0.0	S	20.44	0.1	NS	19.20	0.1	NS	22.15	0.0	S

			35			08			69			48	
	G2	10.27	0.376	NS	9.34	0.636	NS	7.76	0.783	NS	10.71	0.447	NS
	G4	-10.97	0.327	NS	-11.12	0.509	NS	-10.44	0.604	NS	-11.35	0.402	NS
G4	**G1**	31.75	0.003	S	31.56	0.015	S	29.64	0.028	S	33.50	0.005	S
	G2	21.25	0.031	S	20.46	0.108	NS	18.20	0.199	NS	22.06	0.048	S
	G3	10.97	0.327	NS	11.12	0.509	NS	10.44	0.604	NS	11.35	0.402	NS

Table 58 Tukey's test for Number of Shoots pH T5-T8

For treatment 5 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.035 ,0.003, 0.031, and mean difference -20.77, -31.75, -21.25, 20.77, 31.75 and 21.25 on the other hand the remaining group doesn't have significant difference.

For treatment 6 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.015 and with mean difference of -31.56, 31.56 on the other hand the remaining group doesn't have significant difference.

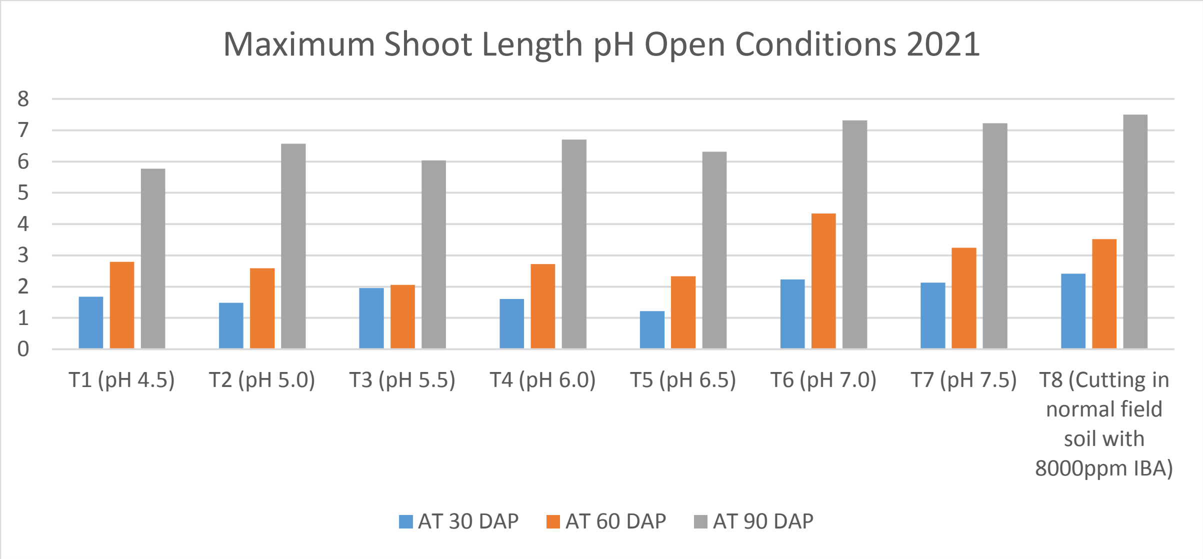
For treatment 7 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.028 and with mean difference of -29.64, 29.64 on the other hand the remaining group doesn't have significant difference.

For treatment 8 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.048 ,0.005 and mean difference -22.15, -33.50, -22.06, 22.15, 33.50 and 22.06 on the other hand the remaining group doesn't have significant difference.

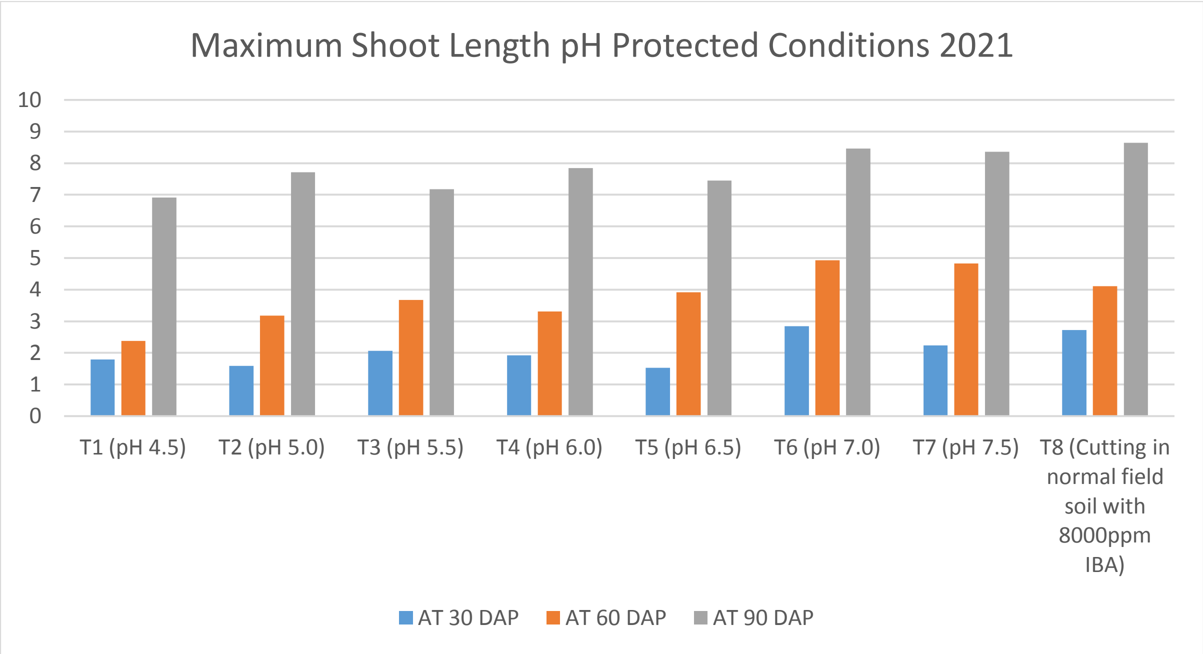
8.21: Impact of different growing media pH on Maximum Shoot Length (cm) of Cutting in Guava (*Psidium guajava* L.):

Treatment Symbol	2021								2022							
	Maximum Shoot Length (cm)								Maximum Shoot Length (cm)							
	Open Conditions				Protected Conditions				Open Conditions				Protected Conditions			
	At 30DAP	**AT 60 DAP**	**AT 90 DAP**	**Mean**	**At 30DAP**	**AT 60 DAP**	**AT 90 DAP**	**Mean**	**At 30DAP**	**AT 60 DAP**	**AT 90 DAP**	**Mean**	**At 30DAP**	**AT 60 DAP**	**AT 90 DAP**	**Mean**
T1 (pH 4.5)	1.68	2.79	5.77	3.41	1.79	2.38	6.91	3.69	1.36	3.47	7.14	3.99	1.59	3.48	7.88	4.32
T2 (pH 5.0)	1.48	2.59	6.57	3.55	1.59	3.18	7.71	4.16	1.16	3.27	7.94	4.12	3.39	4.28	8.68	5.45
T3 (pH 5.5)	1.95	2.06	6.04	3.35	2.06	3.67	7.18	4.30	1.63	2.74	6.41	3.59	2.86	3.75	8.15	4.92
T4 (pH 6.0)	1.61	2.72	6.70	3.68	1.92	3.31	7.84	4.36	1.29	4.40	7.07	4.25	2.52	4.41	8.81	5.25
T5 (pH 6.5)	1.22	2.33	6.31	3.29	1.53	3.92	7.45	4.30	1.90	3.01	7.68	4.20	2.13	4.02	8.42	4.86
T6 (pH 7.0)	2.23	4.34	7.32	4.63	2.84	4.93	8.46	5.41	2.91	4.02	6.69	4.54	3.14	5.03	9.43	5.87
T7 (pH 7.5)	2.13	3.24	7.22	4.20	2.24	4.83	8.36	5.14	1.81	3.92	6.45	4.06	3.04	4.93	8.33	5.43
T8 (Soil with 8000ppm IBA)	2.41	3.52	7.50	4.48	2.72	4.11	8.64	5.16	3.09	4.25	7.98	5.11	4.30	5.21	8.61	6.04
Mean	1.84	2.95	6.68	3.82	2.09	3.79	7.82	4.57	1.89	3.64	7.17	4.23	2.87	4.39	8.54	5.27
CD **at 5%**	0.24	0.46	0.35	0.27	0.26	0.51	0.35	0.34	0.39	0.33	0.31	0.30	0.54	0.35	0.31	0.34

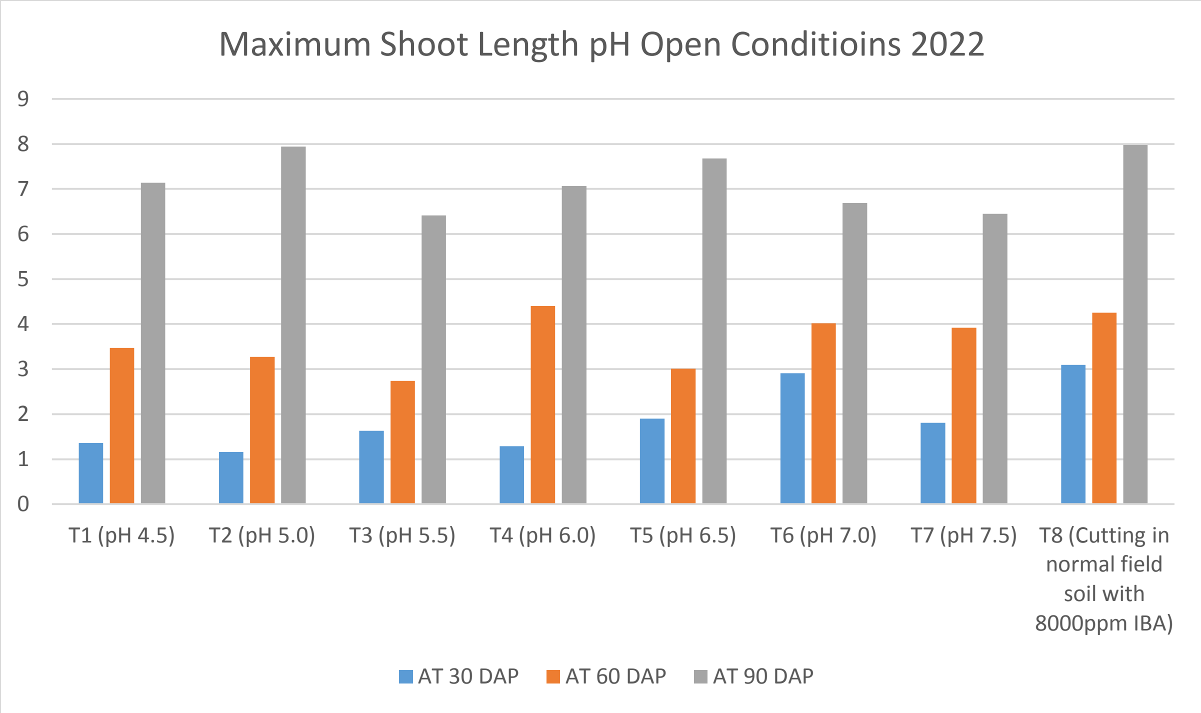
Table 59 Maximum Shoot Length pH



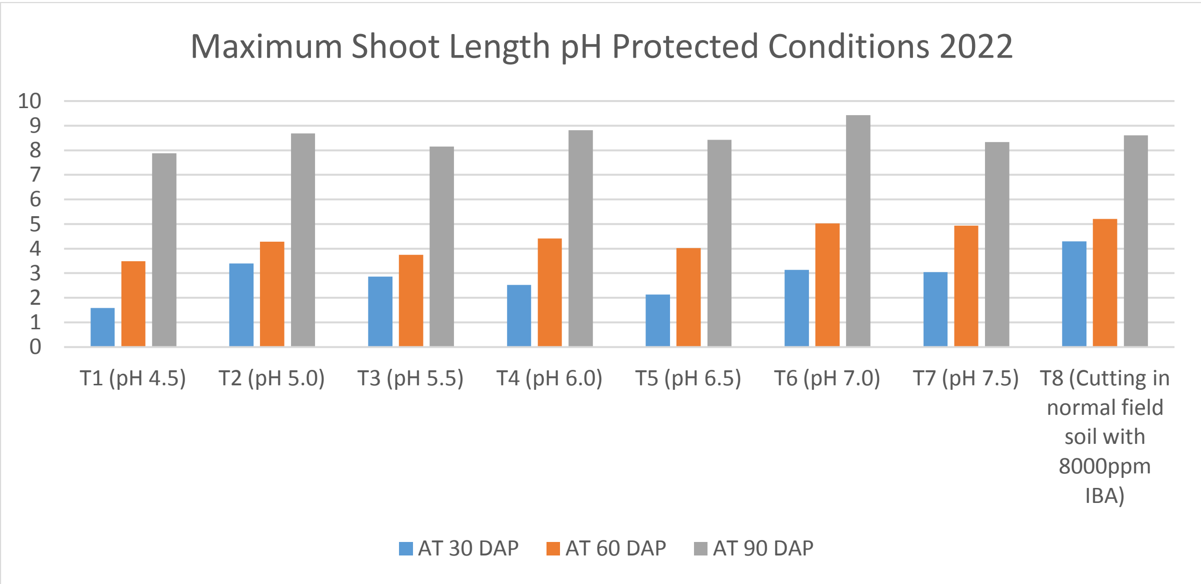
Graph 67 Maximum Shoot Length pH Open Conditions 2021



Graph 68 Maximum Shoot Length pH Protected Conditions 2021



Graph 69 Maximum Shoot Length pH Open Conditions 2022



Graph 70 Maximum Shoot Length pH Protected Conditions 2022

Tukey's test for Maximum Shoot Length pH:

Groups		T1			T2			T3			T4		
		M.D	P-value	Status	M.D	P-Value	Status	M.D	P-Value	Status	M.D	P-Value	Status
G1	G2	-11.08	0.444	NS	-9.75	0.515	NS	-11.32	0.446	NS	-11.08	0.446	NS
	G3	-21.84	0.058	NS	-19.53	0.080	NS	-22.07	0.061	NS	-22.15	0.055	NS
	G4	-32.94	0.007	S	-31.39	0.007	S	-33.54	0.007	S	-33.22	0.007	S
G2	G1	11.08	0.444	NS	9.75	0.515	NS	-11.32	0.446	NS	11.08	0.446	NS
	G3	-10.76	0.467	NS	-9.78	0.512	NS	-10.75	0.486	NS	-11.06	0.447	NS
	G4	-21.86	0.058	NS	-21.64	0.051	NS	-22.22	0.060	NS	-21.14	0.055	NS
G3	G1	21.84	0.058	NS	19.53	0.080	NS	22.07	0.061	NS	22.15	0.055	NS
	G2	10.76	0.467	NS	9.78	0.512	NS	10.75	0.486	NS	11.06	0.447	NS
	G4	-11.10	0.443	NS	-11.86	0.363	NS	-11.46	0.436	NS	-11.07	0.446	NS
G4	G1	32.94	0.007	S	31.39	0.007	S	33.54	0.007	S	33.22	0.007	S
	G2	21.86	0.058	NS	21.64	0.051	NS	22.22	0.060	NS	22.14	0.055	NS
	G3	11.10	0.443	NS	11.86	0.363	NS	11.46	0.436	NS	11.07	0.446	NS

Table 60 Tukey's test for Maximum Shoot Length pH T1-T4

For treatment 1 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.007 and with mean difference of -32.94, 32.94 on the other hand the remaining group doesn't have significant difference.

For treatment 2 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.007 and with mean difference of -31.39, 31.39 on the other hand the remaining group doesn’t have significant difference.

For treatment 3 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.007 and with mean difference of -33.54, 33.54 on the other hand the remaining group doesn’t have significant difference.

For treatment 4 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.007 and with mean difference of -33.22, 33.22 on the other hand the remaining group doesn’t have significant difference.

Groups		**T5**			**T6**			**T7**			**T8**		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-8.73	0.614	NS	-10.79	0.324	NS	-10.25	0.384	NS	-8.48	0.471	NS
	G3	-19.68	0.085	NS	-21.22	0.028	S	-23.67	0.022	S	-19.53	0.033	S
	G4	-31.10	0.009	S	-32.19	0.003	S	-36.43	0.004	S	-30.44	0.003	S
G2	**G1**	8.73	0.614	NS	10.79	0.324	NS	10.25	0.384	NS	8.48	0.471	NS
	G3	-10.95	0.444	NS	-10.43	0.349	NS	-13.41	0.201	NS	-11.04	0.273	NS
	G4	-22.37	0.049	S	-21.40	0.027	S	-26.18	0.023	S	-21.96	0.018	S
G3	**G1**	19.68	0.085	NS	21.22	0.028	S	23.67	0.022	S	19.53	0.033	S
	G2	10.95	0.444	NS	10.43	0.349	NS	13.41	0.201	NS	11.04	0.273	NS
	G4	-11.42	0.411	NS	-10.97	0.312	NS	-12.76	0.305	NS	-10.91	0.281	NS

G4	**G1**	31.10	0.009	S	32.19	0.003	S	36.43	0.004	S	30.44	0.003	S
	G2	22.37	0.049	S	21.40	0.027	S	26.18	0.023	S	21.96	0.018	S
	G3	11.42	0.411	NS	10.97	0.312	NS	12.76	0.305	NS	10.91	0.281	NS

Table 61 Tukey's test for Maximum Shoot Length pH T5-T8

For treatment 5 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.009 and with mean difference of -31.10, 31.10 on the other hand the remaining group doesn't have significant difference.

For treatment 6 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.028 ,0.003, 0.027 and mean difference -21.22, -32.19, -21.40, 21.22, 32.19 and 21.40 on the other hand the remaining group doesn't have significant difference.

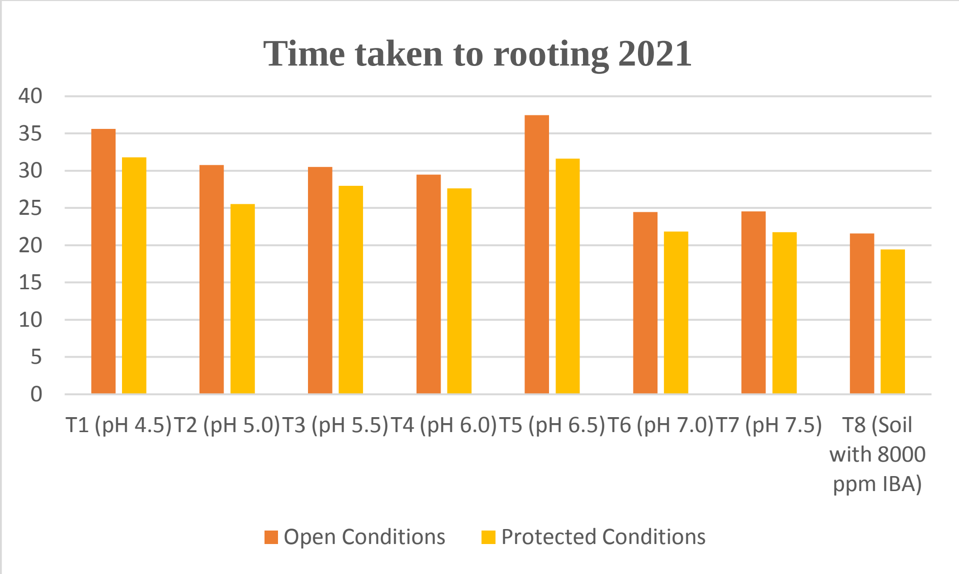
For treatment 7 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.022 ,0.004, 0.023 and mean difference -23.67, -36.43, -26.18, 23.67, 36.76 and 26.18 on the other hand the remaining group doesn't have significant difference.

For treatment 8 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.033 ,0.003, 0.018 and mean difference -30.44, -19.53, -21.96, 19.53, 30.44 and 21.96 on the other hand the remaining group doesn't have significant difference.

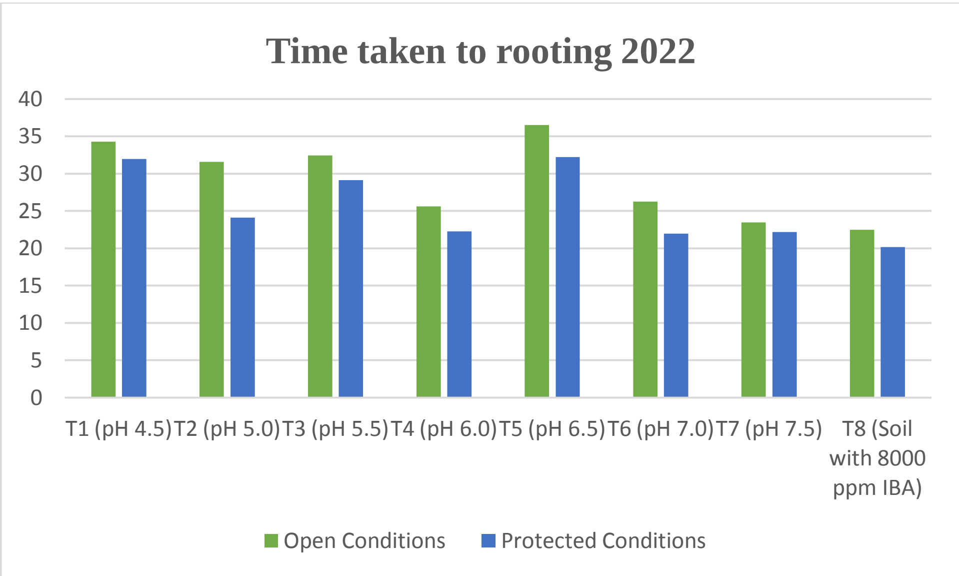
8.22: Impact of different growing media on Time taken to Rooting pH of Cutting in Guava (*Psidium guajava* L.):

Treatment Symbol	2021		2022	
	Time taken to Rooting		Time taken to Rooting	
	Open Conditions	Protected Conditions	Open Conditions	Protected Conditions
	DAP	DAP	DAP	DAP
T1 (pH 4.5)	35.6	31.79	34.29	31.98
T2 (pH 5.0)	30.78	25.54	31.58	24.11
T3 (pH 5.5)	30.53	27.97	32.46	29.15
T4 (pH 6.0)	29.46	27.64	25.6	22.29
T5 (pH 6.5)	37.45	31.64	36.53	32.22
T6 (pH 7.0)	24.46	21.82	26.27	21.96
T7 (pH 7.5)	24.54	21.76	23.48	22.17
T8 (Soil with 8000 ppm IBA)	21.58	19.43	22.48	20.17
CD at 5%	3.17	2.47	2.81	2.41

Table 62 Time taken to Rooting



Graph 71 Time taken to rooting 2021



Graph 72 Time taken to rooting 2022

Tukey’s test for Time taken for Rooting:

Groups		T1			T2			T3			T4		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-5.60	0.536	NS	-7.24	0.353	NS	-5.51	0.545	NS	-11.23	0.472	NS
	G3	-13.41	0.150	NS	-21.33	0.016	S	-16.42	0.206	NS	-21.75	0.043	NS
	G4	-27.36	0.013	S	-33.73	0.001	S	-24.72	0.024	S	-32.51	0.012	S
G2	**G1**	5.60	0.536	NS	7.24	0.353	NS	5.51	0.545	NS	11.23	0.472	NS
	G3	-4.31	0.437	NS	-12.5	0.147	NS	-6.20	0.344	NS	-5.41	0.523	NS
	G4	-17.26	0.123	NS	-24.40	0.004	S	-14.40	0.132	NS	-21.23	0.037	NS
G3	**G1**	13.41	0.150	NS	21.33	0.016	S	16.42	0.206	NS	21.75	0.043	NS
	G2	4.31	0.437	NS	12.5	0.147	NS	6.20	0.344	NS	5.41	0.523	NS
	G4	-11.45	0.444	NS	-12.60	0.154	NS	-11.20	0.474	NS	-5.56	0.537	NS
G4	**G1**	27.36	0.013	S	33.73	0.001	S	24.72	0.024	S	32.51	0.012	S
	G2	17.26	0.123	NS	24.40	0.004	S	14.40	0.132	NS	21.23	0.037	NS
	G3	11.45	0.444	NS	12.60	0.154	NS	11.20	0.474	NS	5.56	0.537	NS

Table 62 Tukey's test for Time taken for Rooting T1-T4

For treatment 1 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.013 and with mean difference of -27.36, 27.36 on the other hand the remaining group doesn’t have significant difference.

For treatment 2 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.016 ,0.001, 0.004, and mean difference -21.33, -33.73, -24.40, 21.33, 33.73 and 24.40 on the other hand the remaining group doesn't have significant difference.

For treatment 3 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.024 and with mean difference of -24.72, 24.72 on the other hand the remaining group doesn't have significant difference.

For treatment 4 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.012 and with mean difference of -32.51, 32.51 on the other hand the remaining group doesn't have significant difference.

Groups		**T5**			**T6**			**T7**			**T8**		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-7.02	0.488	NS	-7.7	0.288	NS	-10.31	0.243	NS	-10.97	0.301	NS
	G3	-33.02	0.070	NS	-33.32	0.029	S	-30.84	0.037	S	-31.83	0.010	S
	G4	-24.43	0.007	S	-21.33	0.003	S	-21.30	0.003	S	-23.43	0.001	S
G2	**G1**	7.02	0.488	NS	7.7	0.288	NS	10.31	0.243	NS	10.97	0.301	NS
	G3	-7.03	0.489	NS	-7.13	0.287	NS	-10.32	0.213	NS	-10.82	0.307	NS
	G4	-32.42	0.024	NS	-30.22	0.023	NS	-31.29	0.034	S	-31.42	0.007	S
G3	**G1**	33.02	0.070	NS	33.32	0.029	S	30.84	0.037	S	31.83	0.010	S
	G2	7.03	0.489	NS	7.13	0.287	NS	10.32	0.213	NS	10.82	0.307	NS

	G4	-13.41	0.297	NS	-9.42	0.214	NS	-10.73	0.207	NS	-10.30	0.333	NS
G4	**G1**	24.43	0.007	S	21.33	0.003	S	21.30	0.003	S	23.43	0.001	S
	G2	32.42	0.024	NS	30.22	0.023	NS	31.29	0.034	S	31.42	0.07	S
	G3	13.41	0.297	NS	9.42	0.214	NS	10.73	0.207	NS	10.30	0.333	NS

Table 63 Tukey's test for time taken to Rooting T5-T8

For treatment 5 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.007 and with mean difference of -24.43, 24.43 on the other hand the remaining group doesn't have significant difference.

For treatment 6 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), and G4(Protected 2022) - G1(Open 2021) With significant values 0.029 ,0.003, and mean difference -33.32, -21.33, 33.32 and 21.33 on the other hand the remaining group doesn't have significant difference.

For treatment 7 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.037 ,0.003, 0.034, and mean difference -30.84, -21.30, -21.29, 30.84, 21.30 and 21.29 on the other hand the remaining group doesn't have significant difference.

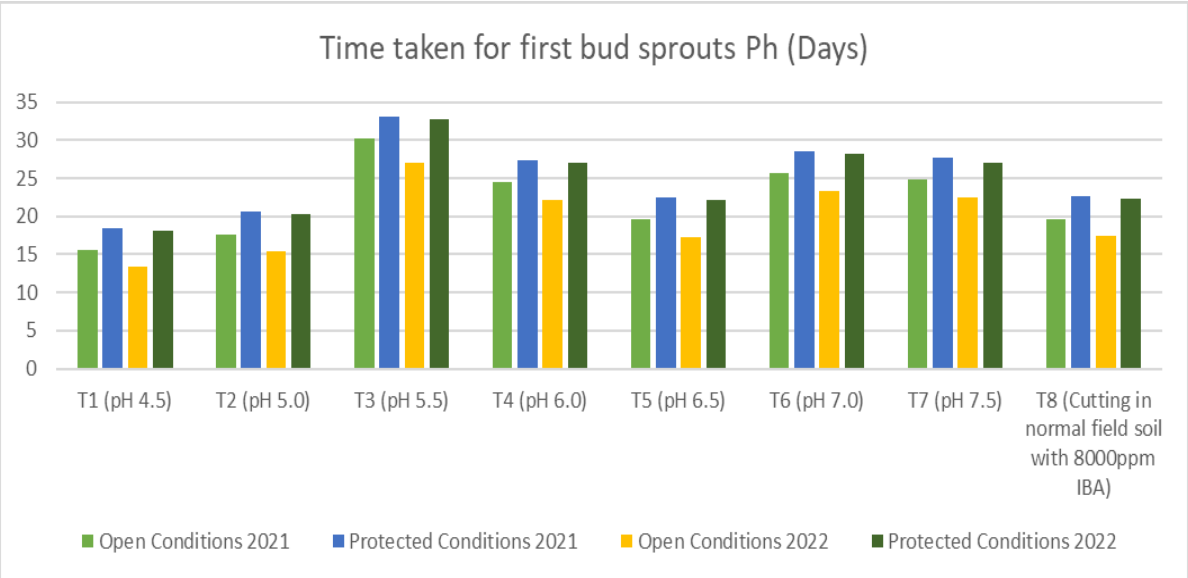
For treatment 8 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.010 ,0.001, 0.07, and mean difference -31.83, -23.43, -31.42, 31.83, 23.43 and 31.42 on the other hand the remaining group doesn't have significant difference.

8.23: Time take for first bud sprouting for Cutting in Guava (*Psidium guajava* L.):

Treatment Symbol	2021 Time taken for first bud sprouts (Days)		2022 Time taken for first bud sprouts (Days)	
	Open Conditions	Protected Conditions	Open Conditions	Protected Conditions
T1 (pH 4.5)	27.03	22.52	27.65	24.75
T2 (pH 5.0)	24.21	15.43	20.56	17.66
T3 (pH 5.5)	32.68	26.09	33.03	30.13
T4 (pH 6.0)	26.99	22.21	27.34	24.44
T5 (pH 6.5)	23.12	18.34	24.47	21.57
T6 (pH 7.0)	28.16	23.38	29.51	25.61
T7 (pH 7.5)	22.23	17.45	22.58	19.68
T8 (Cutting in normal field soil with 8000ppm IBA)	18.14	13.36	21.49	15.59
CD **at 5%**	2.91	2.55	2.49	2.91

Table 64 Time taken for first bud sprouts Ph

The table above shows the time it takes for the first buds to appear in 2021 and 2022. The critical difference (CD) is shown, which is the smallest statistically significant difference between two means at a 95% confidence level. The table demonstrates that the time required for the first bud to emerge varies with pH and environmental conditions. In general, the protected conditions require more time than the exposed conditions. Additionally, the duration is lengthened at lower pH levels. The critical difference demonstrates that statistically significant differences exist between the means of certain treatments. In 2021 and 2022, for instance, the difference between the norms for T1 (pH 4.5) and T8 (Cutting in typical field soil with 8000ppm IBA) is statistically significant. This table provides information beneficial for comprehending the factors that influence the time required for the first bloom to emerge. The data in the table could be utilised to optimise plant growth conditions.

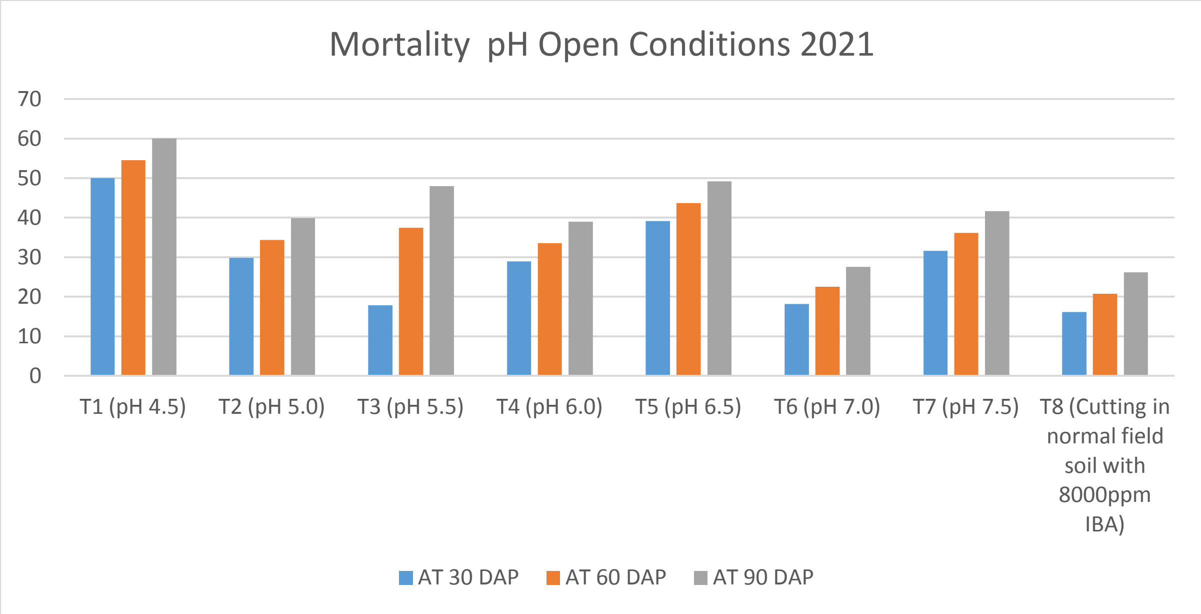


Graph 73 Time taken for first bud sprouts Ph (Days)

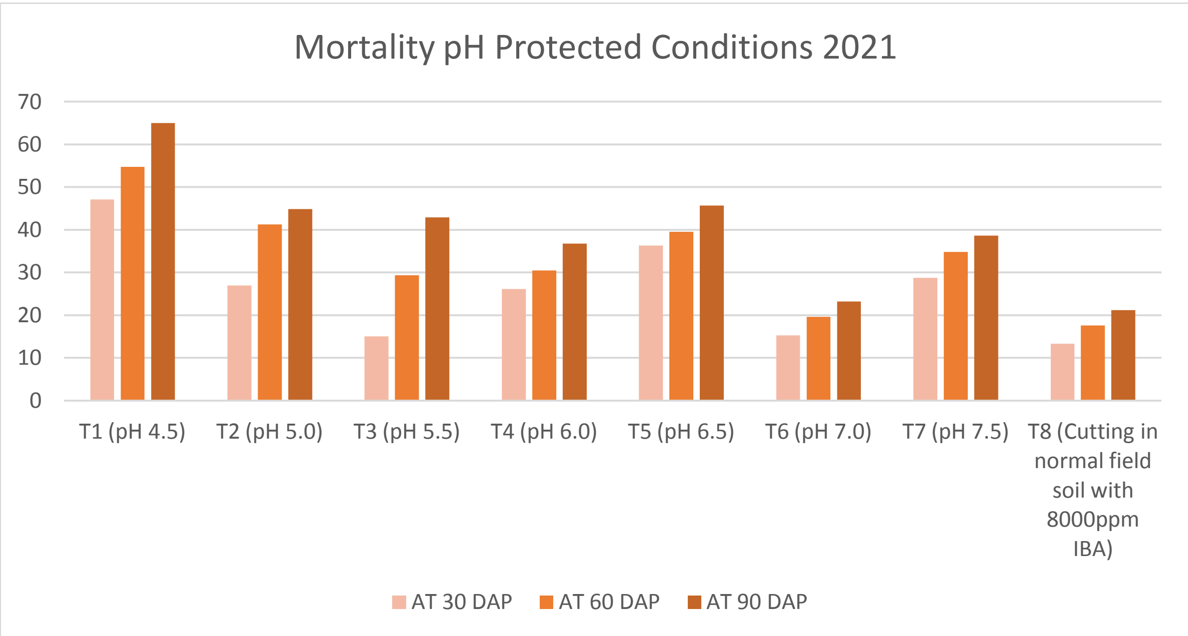
8.24: Impact of different growing media pH on Mortality of Cutting in Guava (*Psidium guajava* L.):

Treatment Symbol	2021								2022							
	Mortality								Mortality							
	Open Conditions				Protected Conditions				Open Conditions				Protected Conditions			
	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean
T1 (pH 4.5)	49.97	54.54	60.04	54.85	47.12	54.69	65.00	55.60	52.86	57.87	63.03	57.92	45.13	59.10	63.11	55.78
T2 (pH 5.0)	29.79	34.36	39.86	34.67	26.94	41.25	44.82	37.67	32.68	37.69	42.85	37.74	24.95	38.92	42.93	35.60
T3 (pH 5.5)	17.87	37.44	47.94	34.42	15.02	29.33	42.90	29.08	20.76	25.77	30.93	25.82	13.03	27.00	31.01	23.68
T4 (pH 6.0)	28.95	33.52	39.02	33.83	26.10	30.46	36.72	31.09	31.84	36.85	42.01	36.90	24.11	38.08	42.09	34.76
T5 (pH 6.5)	39.12	43.69	49.19	44.00	36.27	39.49	45.67	40.48	42.01	47.02	52.18	47.07	34.28	48.25	52.26	44.93
T6 (pH 7.0)	18.13	22.51	27.56	22.73	15.28	19.59	23.16	19.34	14.02	16.03	21.19	17.08	13.29	17.26	21.27	17.27
T7 (pH 7.5)	31.57	36.14	41.64	36.45	28.72	34.81	38.61	34.05	34.46	39.47	44.63	39.52	26.73	40.70	44.71	37.38
T8 (Soil with 8000ppm IBA)	16.15	20.72	26.22	21.03	13.30	17.61	21.18	17.36	9.04	14.05	19.21	14.10	11.31	15.28	19.29	15.29
Mean	28.94	35.37	41.43	35.25	26.09	33.40	39.76	33.09	29.71	34.34	39.50	34.52	24.10	35.57	39.58	33.09
CD at 5%	6.76	6.31	5.67	6.57	5.62	7.45	8.76	7.65	7.62	7.82	8.23	8.15	7.21	7.78	8.55	8.10

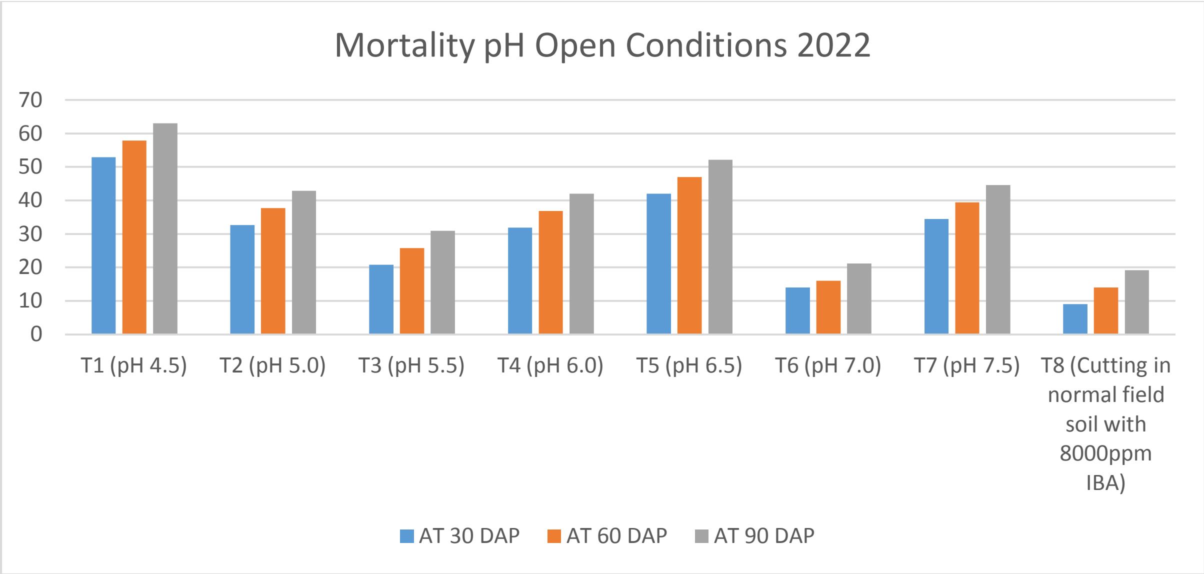
Table 65 Mortality



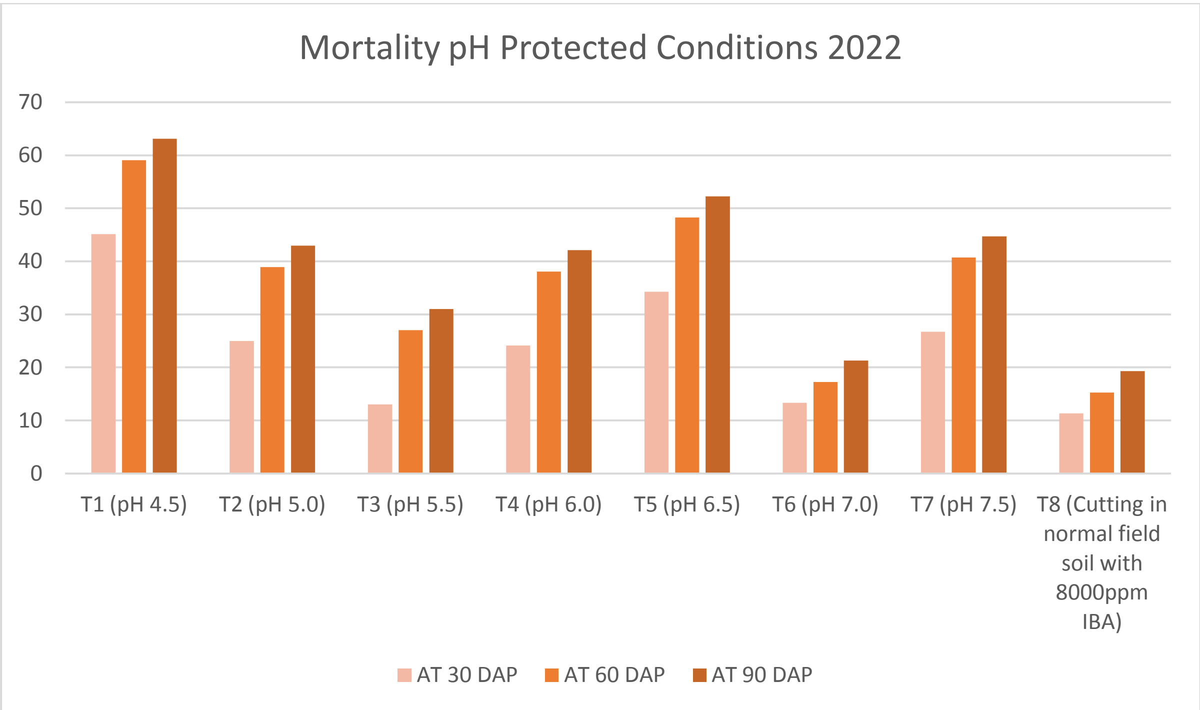
Graph 74 Mortality Open Conditions 2021



Graph 75 Mortality Protected Conditions 2021



Graph 76 Mortality Open Conditions 2022



Graph 77 Mortality Protected Conditions 2022

Tukey's test for Mortality:

Groups		T1			T2			T3			T4		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-11.14	0.329	NS	-4.99	0.879	NS	-10.18	0.665	NS	-9.47	0.239	NS
	G3	-19.98	0.045	S	-16.10	0.158	NS	-19.62	0.192	NS	-21.24	0.007	S
	G4	-31.90	0.003	S	-24.26	0.029	S	-29.05	0.043	S	-32.13	0.000	S
G2	**G1**	11.14	0.329	NS	4.99	0.879	NS	10.18	0.665	NS	9.47	0.239	NS
	G3	-8.84	0.506	NS	-11.11	0.408	NS	-9.43	0.712	NS	-11.77	0.121	NS
	G4	-20.76	0.038	S	-19.27	0.082	NS	-18.86	0.216	NS	-22.65	0.005	S
G3	**G1**	19.98	0.045	S	16.10	0.158	NS	19.62	0.192	NS	21.24	0.007	S
	G2	8.84	0.506	NS	11.11	0.408	NS	9.43	0.712	NS	22.77	0.121	NS
	G4	-11.92	0.280	NS	-8.15	0.640	NS	-9.43	0.712	NS	-10.88	0.158	NS
G4	**G1**	31.90	0.003	S	24.26	0.029	S	29.05	0.043	S	32.13	0.000	S
	G2	20.76	0.038	S	19.27	0.082	NS	18.86	0.216	NS	22.65	0.005	S
	G3	11.92	0.280	NS	8.15	0.640	NS	9.43	0.712	NS	10.88	0.158	NS

Table 66 Tukey's test for Mortality T1-T4

For treatment 1 there is a significant difference between G1(Open 2021)- G3(Open 2022), G1(Open 2021)- G4(Protected 2022), G2(Protected 2021)- G4(Protected 2022) , G3(Open 2022) – G1(Open 2021) , G4(Protected 2022) –G1(Open 2021), G4(Protected 2022)-G2(Protected 2022)with significant values 0.045, 0.003,0.038,0.045,0.003,0.038,0.280with mean difference -19.98, -31.90, -20.76,19..98,31.90,20.76 on the other hand the remaining group doesn't have significant difference

For treatment 2 there is a significant difference between G1(Open 2021)- G4(Protected 2022), G4(Protected 2022)- G1(Open 2021) With significant values 0.029 ,0.029 with mean difference -24.26, 24.26, on the other hand the remaining group doesn't have significant difference

For treatment 3 there is a significant difference between G1(Open 2021)- G4(Protected 2022), G4(Protected 2022)-G1(Open 2021) With significant values 0.043 ,0.043, and mean difference -29.05,29.05 on the other hand the remaining group doesn't have significant difference

For treatment 4 there is a significant difference between G1(Open 2021)- G3(Open 2022), G1(Open 2021) – G4(Protected 2022), G2(Protected 2021)-G4(Protected 2022) , G3(Open 2022)-G1(Open 2021), G4(Protected 2022)-G1(Open 2021), G4(Protected 2022)-G2(Protected 2021) with significant values 0.007, 0.000, 0.005, 0.007, 0.000, 0.005 with mean difference -21.24, -31.13, -22.65, 21.24, 32.13, 22.65 on the other hand the remaining group doesn't have significant difference.

Groups		**T5**			**T6**			**T7**			**T8**		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-11.11	0.348	NS	-4.34	0.933	NS	-13.96	0.450	NS	-11.19	0.383	NS
	G3	-22.81	0.027	S	-15.60	0.229	NS	-24.04	0.104	NS	-23.60	0.029	S
	G4	-32.82	0.003	S	-25.53	0.035	S	-34.57	0.020	S	-32.48	0.005	S
G2	**G1**	11.11	0.348	NS	4.34	0.933	NS	13.96	0.450	NS	11.19	0.383	NS
	G3	-11.69	0.311	NS	-11.26	0.468	NS	-10.07	0.686	NS	-12.41	0.305	NS
	G4	-21.70	0.034	S	-21.19	0.080	NS	-20.60	0.177	NS	-21.29	0.048	S
G3	**G1**	22.81	0.0	S	15.60	0.2	NS	24.04	0.1	NS	23.60	0.0	S

			27			29			04			29	
	G2	11.69	0.311	NS	11.26	0.468	NS	10.07	0.686	NS	12.41	0.305	NS
	G4	-10.01	0.429	NS	-9.93	0.564	NS	-10.52	0.658	NS	-8.87	0.305	NS
G4	**G1**	32.82	0.003	S	25.53	0.035	S	34.57	0.020	S	32.48	0.005	S
	G2	21.70	0.034	S	21.19	0.080	NS	20.60	0.177	NS	21.29	0.048	S
	G3	10.01	0.429	NS	9.93	0.564	NS	10.52	0.658	NS	8.87	0.561	NS

Table 67 Tukey's test for Mortality T5-T8

For treatment 5 there is a significant difference between G1(Open 2021)-G3(Open 2022), G1(Open 2021)- G4(Protected 2022). G2(Protected 2021)- G4(Protected 2022), G3(Open 2022)-G1(Open 2021), G4(Protected 2022)- G1(Open 2021), G4(Protected 2022)-G2(Protected 2021) with significant values 0.027, 0.0030.034, 0.027, 0.003,0.034 with mean difference -22.81, -32.82, -21.70, 22.81, 32.82, 21.70 on the other hand the remaining group doesn't have significant difference

For treatment 6 there is a significant difference between G1(Open 2021)- G4(Protected 2022), G4(Protected 2022)-G1(Open 2021) with significant values 0.035, 0.035 with mean difference -25.53and 25.53 on the other hand the remaining group doesn't have significant difference.

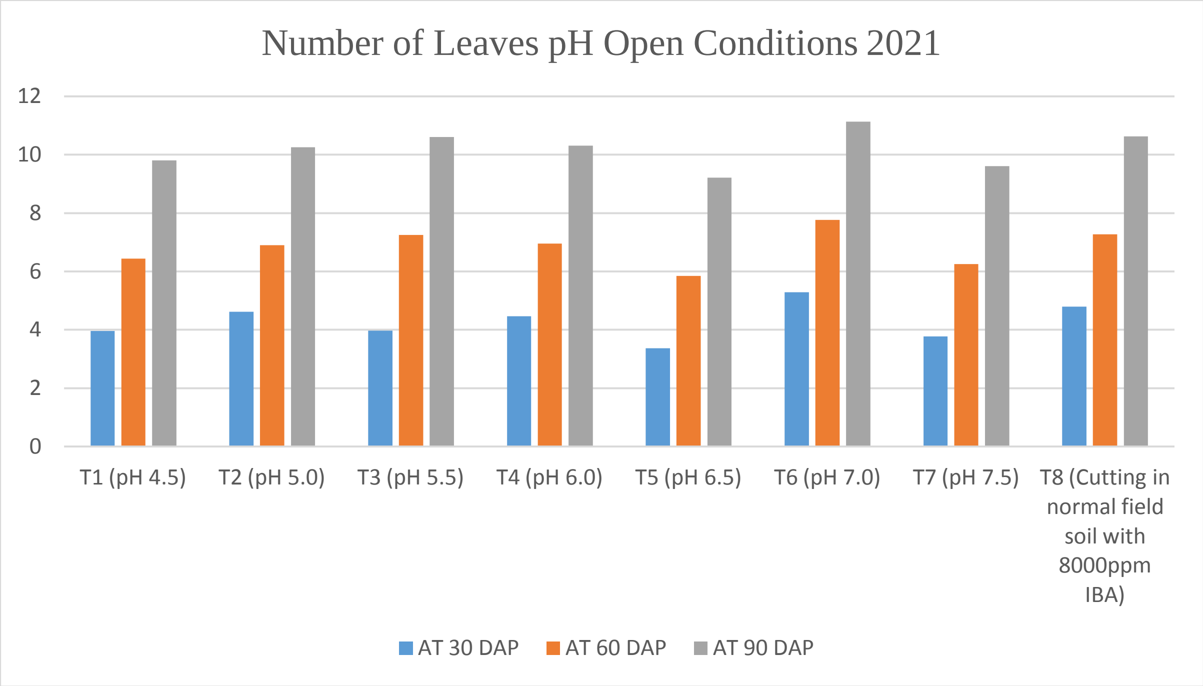
For treatment 7 there is a significant difference between G1(Open 2021)-G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.020 ,0.020 with mean difference -34.57,34.57 on the other hand the remaining groups doesn't have significant difference

For treatment 8 there is a significant difference between G1(Open 2021)- G3(Open 2022), G1(Open 2021)-G4(Protected 2022) , G2(Protected 2021)-G4(Protected 2022) ,G3(Open 2021)-G1(Open 2021) ,G4(Protected 2022)- G1(Open 2021), G4(Protected 2022)-G2(Protected 2022) with significant values 0.029,0.005,0.048, 0.029, 0.005,0.048,with mean difference -23.60,-32.48,-21.29,23.60,32.48,21.29 on the other hand the remaining group doesn't have significant difference

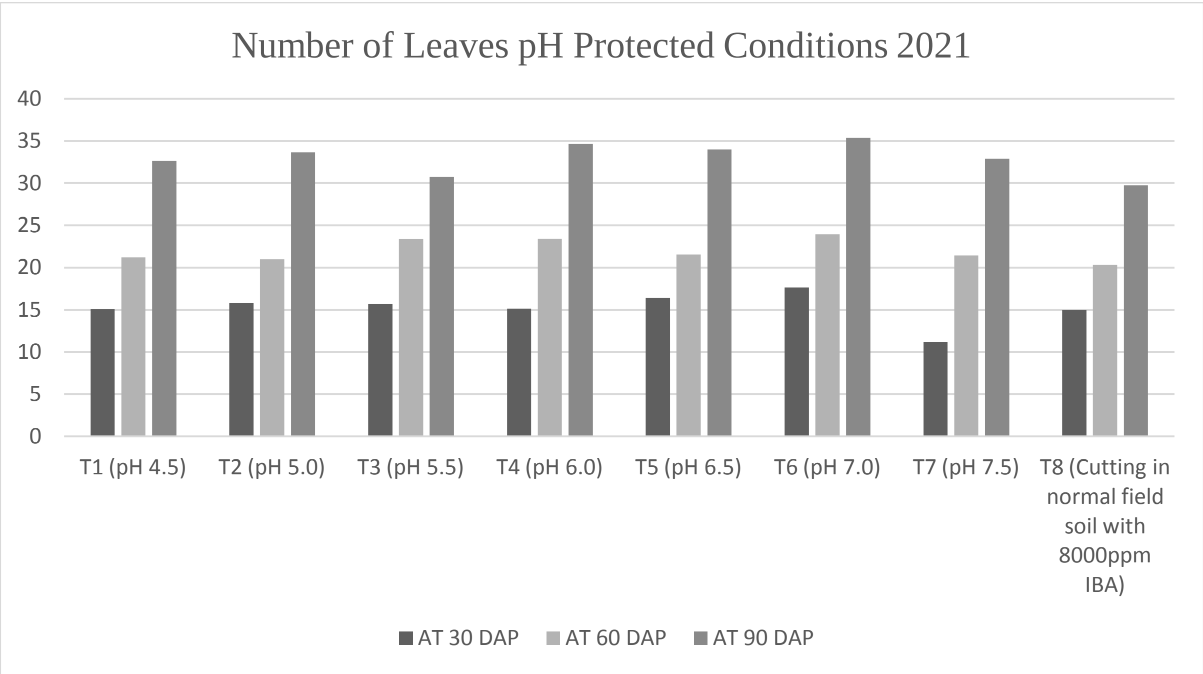
8.25: Impact of different growing media pH on Number of Leaves of Cutting in Guava (*Psidium guajava* L.):

Treatment Symbol	2021								2022							
	Number of Leaves								Number of Leaves							
	Open Conditions				Protected Conditions				Open Conditions				Protected Conditions			
	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean	At 30DAP	AT 60 DAP	AT 90 DAP	Mean
T1 (pH 4.5)	3.96	6.44	9.80	6.73	4.66	7.57	11.59	7.94	3.80	6.12	9.61	6.51	5.03	7.90	10.31	7.75
T2 (pH 5.0)	4.62	6.90	10.26	7.26	6.22	8.03	12.05	8.77	4.46	7.58	10.07	7.37	6.69	8.36	10.65	8.57
T3 (pH 5.5)	3.97	7.25	10.61	7.28	6.57	8.38	12.40	9.12	4.81	6.93	10.42	7.39	5.86	8.73	11.02	8.54
T4 (pH 6.0)	4.47	6.95	10.31	7.24	6.07	8.08	12.10	8.75	4.31	6.63	10.12	7.02	5.54	8.41	10.70	8.22
T5 (pH 6.5)	3.37	5.85	9.21	6.14	4.97	6.98	11.00	7.65	3.21	5.53	9.02	5.92	4.44	7.31	9.60	7.12
T6 (pH 7.0)	5.29	7.77	11.13	8.06	6.89	8.90	12.92	9.57	5.13	7.45	10.94	7.84	7.36	9.23	11.52	9.37
T7 (pH 7.5)	3.77	6.25	9.61	6.54	4.37	7.38	11.40	7.72	3.61	5.93	9.42	6.32	4.84	7.71	10.00	7.52
T8 (Soil with 8000ppm IBA)	4.79	7.27	10.63	7.56	5.39	8.40	12.42	8.74	4.63	6.95	10.44	7.34	8.04	8.71	11.00	9.25
Mean	4.28	6.84	10.20	7.10	5.64	7.97	11.99	8.53	4.25	6.64	10.01	6.96	5.98	8.30	10.60	8.29
CD **at 5%**	0.38	0.42	0.33	0.45	0.51	0.37	0.53	0.38	0.43	0.41	0.45	0.51	0.72	0.48	0.36	0.45

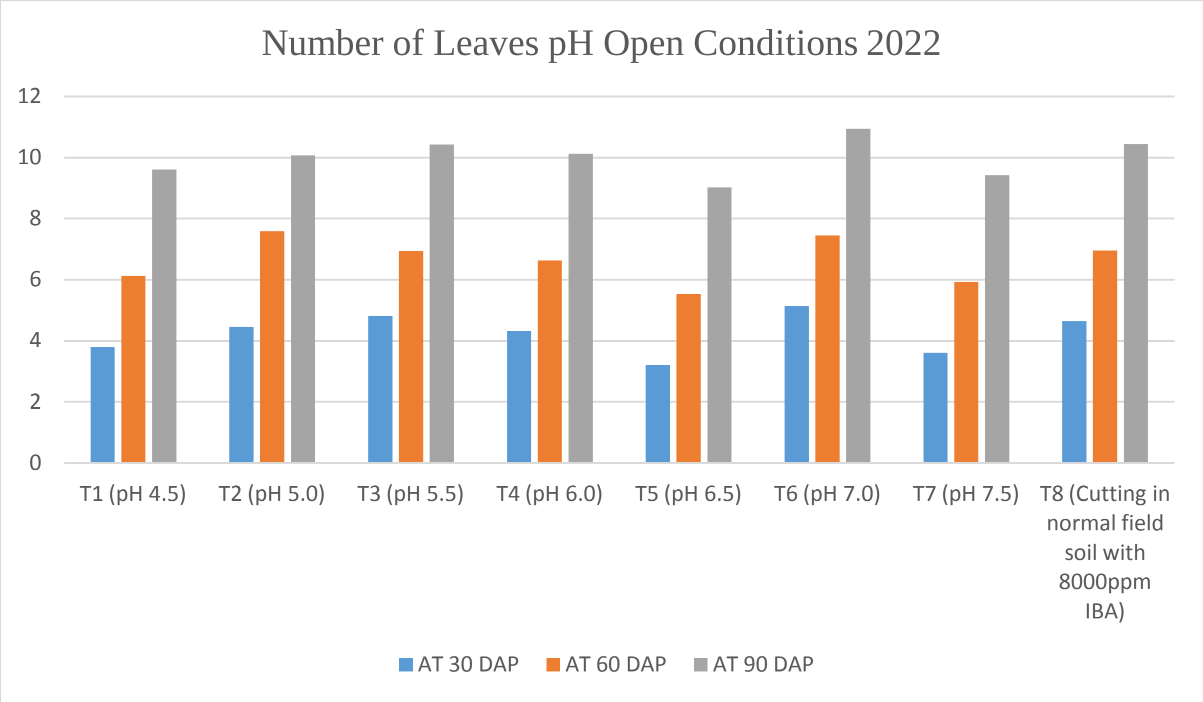
Table 68 Number of Leaves



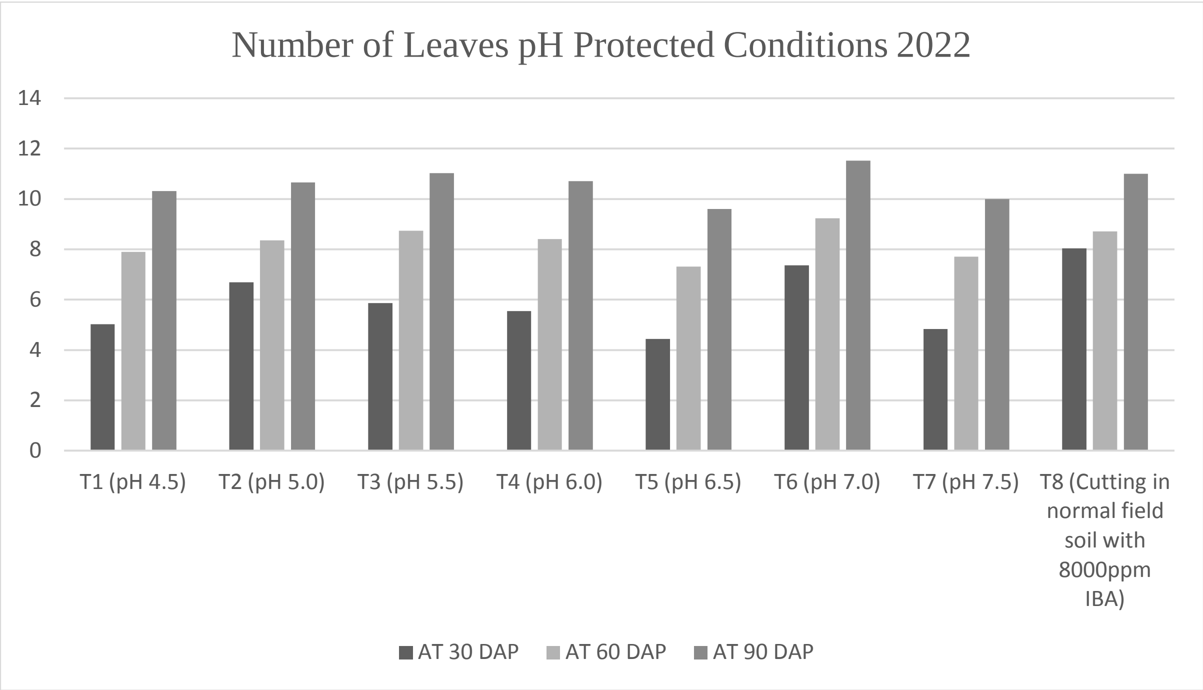
Graph 78 Number of Leaves Open Conditions 2021



Graph 79 Number of Leaves pH Protected Conditions 2021



Graph 80 Number of Leaves pH Open Conditions 2022



Graph 81 Number of Leaves pH Protected Conditions 2022

Tukey’s test for Number of Leaves pH:

Groups		T1			T2			T3			T4		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-11.09	0.433	NS	-11.48	0.467	NS	-12.01	0.310	NS	-10.01	0.613	NS
	G3	-17.40	0.134	NS	-22.17	0.072	NS	-23.14	0.028	S	-21.12	0.109	NS
	G4	-28.87	0.014	S	-34.29	0.008	S	-34.15	0.003	S	-26.86	0.040	S
G2	**G1**	11.09	0.433	NS	11.48	0.467	NS	12.01	0.310	NS	10.01	0.613	NS
	G3	-6.31	0.802	NS	-10.69	0.522	NS	-11.12	0.368	NS	-11.10	0.537	NS
	G4	-17.78	0.125	NS	-22.80	0.064	NS	-22.13	0.035	S	-16.84	0.228	NS
G3	**G1**	6.31	0.802	NS	10.69	0.522	NS	11.12	0.368	NS	11.10	0.537	NS
	G2	-11.47	0.407	NS	-12.11	0.425	NS	-11.01	0.375	NS	-5.74	0.887	NS
	G4	28.87	0.014	S	34.29	0.008	S	34.15	0.003	S	26.86	0.040	S
G4	**G1**	17.78	0.125	NS	22.80	0.064	NS	22.13	0.035	S	16.84	0.228	NS
	G2	11.47	0.407	NS	12.11	0.425	NS	11.01	0.375	NS	5.74	0.887	NS
	G3	-11.09	0.433	NS	-11.48	0.467	NS	-12.01	0.310	NS	-10.01	0.613	NS

Table 69 Tukey's test for Number of Leaves pH T1-T4

For treatment 1 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.014 and with mean difference of -28.87, 28.87 on the other hand the remaining group doesn’t have significant difference.

For treatment 2 there is a significant difference between G1(Open 2021) - G4(Protected 2022), G4(Protected 2022) - G1(Open 2021) With significant values 0.008 with mean difference -34.29, 34.29, on the other hand the remaining group doesn’t have significant difference.

For treatment 3 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.028 ,0.003, 0.035 and mean difference -23.14, -34.15, -22.13, 23.14, 34.15 and 22.13 on the other hand the remaining group doesn’t have significant difference.

For treatment 4 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.040 and with mean difference of -26.86, 26.86 on the other hand the remaining group doesn’t have significant difference.

Groups		**T5**			**T6**			**T7**			**T8**		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-9.46	0.640	NS	-10.77	0.467	NS	-9.44	0.680	NS	-10.40	0.264	NS
	G3	-21.51	0.095	NS	-22.54	0.051	NS	-20.55	0.140	NS	-24.90	0.006	S
	G4	-33.62	0.011	S	-33.61	0.006	S	-31.96	0.021	S	-35.68	0.001	S
G2	**G1**	9.46	0.640	NS	10.77	0.467	NS	9.44	0.680	NS	10.40	0.264	NS
	G3	-12.05	0.460	NS	-11.77	0.397	NS	-11.10	0.568	NS	-14.49	0.090	NS
	G4	-24.16	0.059	NS	-22.84	0.048	S	-22.52	0.100	NS	-25.27	0.005	S
G3	**G1**	12.05	0.460	NS	11.77	0.397	NS	20.55	0.140	NS	24.90	0.006	S
	G2	-12.10	0.457	NS	-11.07	.0445	NS	11.10	0.568	NS	14.49	0.090	NS

	G4	33.62	0.011	S	33.61	0.006	S	-11.41	0.548	NS	-10.78	0.240	NS
G4	**G1**	24.16	0.059	NS	22.84	0.048	S	31.96	0.021	S	35.68	0.001	S
	G2	12.10	0.457	NS	11.07	0.445	NS	22.52	0.100	NS	25.27	0.005	S
	G3	-9.46	0.640	NS	-10.77	0.467	NS	11.41	0.548	NS	10.78	0.240	NS

Table 70 Tukey's test for Number of Leaves pH T5-T8

For treatment 5 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.011 and with mean difference of -33.62, 33.62 on the other hand the remaining group doesn't have significant difference.

For treatment 6 there is a significant difference between G1(Open 2021)- G4(Protected 2022), G2(Protected 2021) – G4(Protected 2022) G4(Protected 2022) - G1(Open 2021), G4(Protected 2022) – G2(Protected 2021) with significant values 0.048, 0.006 with mean difference of -33.61, -22.84, 33.61 and 22.84 on the other hand the remaining group doesn't have significant difference.

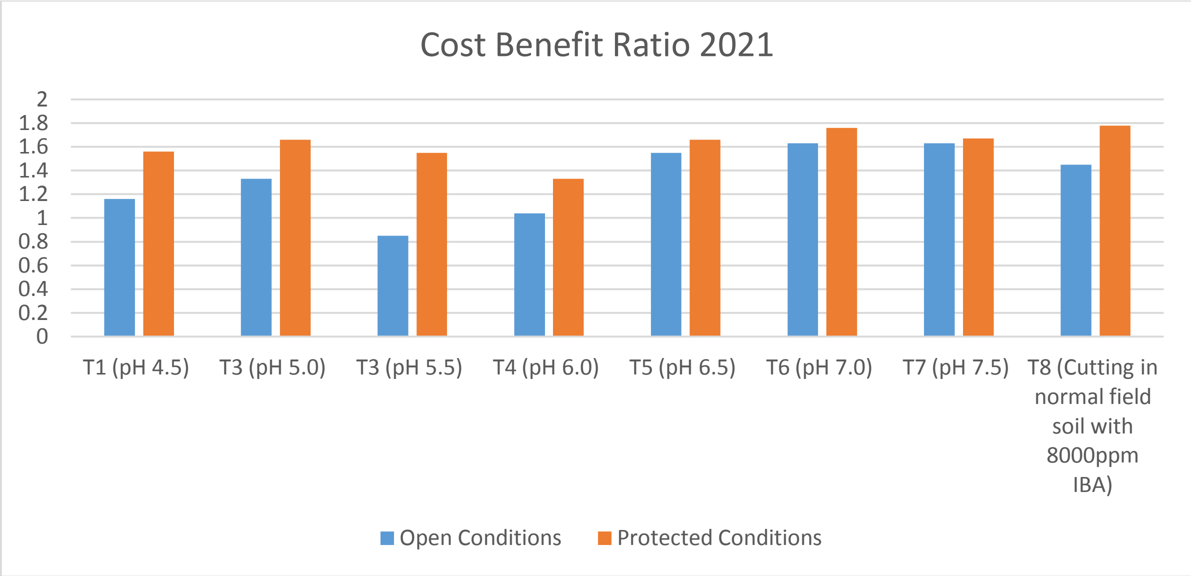
For treatment 7 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.021 and with mean difference of -31.96, 31.96 on the other hand the remaining group doesn't have significant difference.

For treatment 8 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.006 ,0.001, 0.005 and mean difference -24.90, -35.68, -25.27, 24.90, 35.68 and 25.27 on the other hand the remaining group doesn't have significant difference.

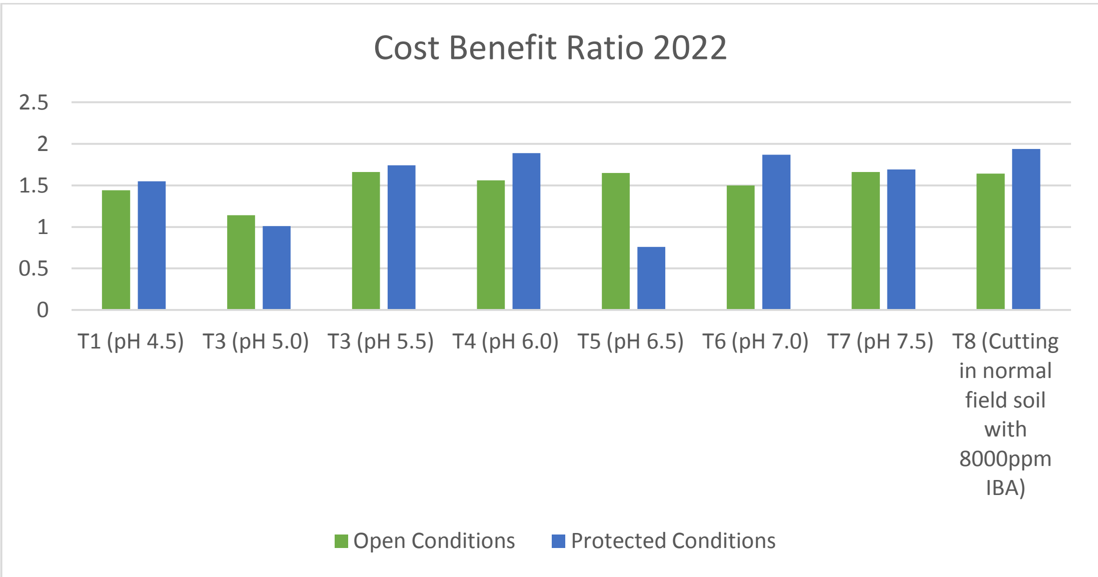
8.26: Impact of different growing media on Cost Benefit Ratio pH of Cutting in Guava (*Psidium guajava* L.):

Treatment Symbol	2021		2022	
	Cost Benefit Ratio		Cost Benefit Ratio	
	Open Conditions	Protected Conditions	Open Conditions	Protected Conditions
T1 (pH 4.5)	1.16	1.56	1.44	1.55
T3 (pH 5.0)	1.33	1.66	1.14	1.01
T3 (pH 5.5)	0.85	1.55	1.66	1.74
T4 (pH 6.0)	1.04	1.33	1.56	1.89
T5 (pH 6.5)	1.55	1.66	1.65	0.76
T6 (pH 7.0)	1.63	1.76	1.5	1.87
T7 (pH 7.5)	1.63	1.67	1.66	1.69
T8 (Cutting in normal field soil with 8000ppm IBA)	1.45	1.78	1.64	1.94
CD at 5%	0.16	0.09	0.10	0.23

Table 71 Cost Benefit Ratio pH



Graph 82 Cost Benefit Ratio 2021



Graph 83 Cost Benefit Ratio 2022

Tukey’s test for Cost Benefit Ratio

Groups		T1			T2			T3			T4		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-4.58	0.327	NS	-10.21	0.54	NS	-10.73	0.171	NS	-4.4	0.413	NS
	G3	-33.92	0.018	S	-18.21	0.141	NS	-31.04	0.019	S	-30.04	0.079	NS
	G4	-12.27	0.001	S	-39.33	0.030	S	-13.49	0.004	S	-4.35	0.009	S
G2	**G1**	4.58	0.327	NS	10.21	0.54	NS	10.73	0.171	NS	4.4	0.413	NS
	G3	-4.17	0.380	NS	-7.99	0.735	NS	-10.4	0.401	NS	-8.91	0.200	NS
	G4	-35.08	0.014	S	-18.21	0.141	NS	-31.77	0.014	S	-30.13	0.078	NS
G1	**G2**	33.92	0.018	S	18.21	0.141	NS	31.04	0.019	S	30.04	0.074	NS
	G3	4.17	0.380	NS	7.99	0.735	NS	10.4	0.401	NS	8.91	0.200	NS
	G4	-4.71	0.124	NS	-10.21	0.54	NS	-4.45	0.133	NS	-4.30	0.437	NS
G4	**G1**	12.27	0.001	S	39.33	0.030	S	13.49	0.004	S	4.35	0.009	S
	G2	35.08	0.014	S	18.21	0.141	NS	31.77	0.014	S	30.13	0.078	NS
	G3	4.71	0.124	NS	10.21	0.54	NS	4.45	0.133	NS	4.30	0.437	NS

Table 72 Tukey's test for Cost Benefit Ratio T1-T4

For treatment 1 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.018 ,0.001, 0.014, and mean difference -33.92,

-12.27, -35.08, 33.92, 35.08 and 33.92 on the other hand the remaining group doesn't have significant difference.

For treatment 2 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.030 and with mean difference of -39.33, 39.33 on the other hand the remaining group doesn't have significant difference.

For treatment 3 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.019 ,0.004, 0.014, and mean difference -31.04, -13.49, -31.77, 31.04, 13.49 and 31.77 on the other hand the remaining group doesn't have significant difference.

For treatment 4 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.009 and with mean difference of -31.25, 31.25 on the other hand the remaining group doesn't have significant difference.

Groups		**T5**			**T6**			**T7**			**T8**		
		M.D	**P-value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**	**M.D**	**P-Value**	**Status**
G1	**G2**	-4.34	0.407	NS	-9.74	0.229	NS	-30.33	0.202	NS	-4.43	0.375	NS
	G3	-22.23	0.044	S	-23.79	0.320	NS	-23.32	0.303	NS	-22.43	0.040	S
	G4	-33.29	0.005	S	-33.90	0.022	S	-35.03	0.030	S	-32.87	0.005	S
G2	**G1**	4.34	0.407	NS	9.74	0.229	NS	30.33	0.202	NS	4.43	0.375	NS
	G3	-4.08	0.44	NS	-32.05	0.537	NS	-4.23	0.522	NS	-30.98	0.407	NS
	G4	-22.35	0.045	S	-22.32	0.42	NS	-24.90	0.055	NS	-23.43	0.049	S
G3	**G1**	22.23	0.0	S	23.79	0.3	NS	23.32	0.3	NS	22.43	0.0	S

			44			20			03			40	
	G2	4.08	0.44	NS	32.05	0.537	NS	4.23	0.522	NS	30.98	0.407	NS
	G4	-4.02	0.432	NS	-30.4	0.244	NS	-33.27	0.374	NS	-30.45	0.445	NS
G4	**G1**	33.29	0.005	S	33.90	0.022	S	35.03	0.030	S	32.87	0.005	S
	G2	22.35	0.045	S	22.32	0.42	NS	24.90	0.055	NS	23.43	0.049	S
	G3	4.02	0.432	NS	30.4	0.244	NS	33.27	0.374	NS	30.45	0.445	NS

Table 73 Tukey's test for Cost Benefit Ratio T5-T8

For treatment 5 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.044 ,0.005, 0.045, and mean difference -22.23, -33.29, -21.35, 22.23, 33.29 and 21.35 on the other hand the remaining group doesn’t have significant difference.

For treatment 6 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.022 and with mean difference of -33.90, 33.90 on the other hand the remaining group doesn’t have significant difference.

For treatment 7 there is a significant difference between G1(Open 2021) - G4(Protected 2022) and G4(Protected 2022) - G1(Open 2021) with significant values 0.030 and with mean difference of -35.03, 35.03 on the other hand the remaining group doesn’t have significant difference.

For treatment 8 there is a significant difference between G1(Open 2021) - G3(Open 2022), G1(Open 2021) - G4(Protected 2022), G2(Protected 2021) - G4(Protected 2022), G3(Open 2022) – G1(Open 2021), G4(Protected 2022) - G1(Open 2021) and G4(Protected 2022) – G2(Protected 2021) With significant values 0.040 ,0.005, 0.049 and mean difference -22.43, -32.87, -23.43, 22.43, 32.87 and 23.43 on the other hand the remaining group doesn’t have significant difference.

9. Discussion:

In this study, the effect of different rooting medium and their pH on the rooting behaviour of semi-hardwood stem cuttings of guava *(Psidium guajava L.)* was explored under circumstances typical of the Himalayan foothills. This study examined the potential of using natural substances as natural rooting hormone for the stimulation of rooting in hardwood cuttings of Guava by experimenting with various concentrations and combinations of natural treatments. *(El-zayat*, 2010) Guava semi-hardwood stem cuttings' rooting behaviour is also affected by the pH of the rooting medium, which is another key component that plays a role in this process. On the other hand, in the foothillof the Himalayas, the pH of the rooting medium could be different owing to the presence of certain minerals and organic materials. As a result, the pH of the Rooting medium must to be checked on a frequent basis so as to make certain that it remains within the acceptable range.

The rooting medium and its pH have a substantial effect on the rooting behaviour of guava stem cuttings in the Himalayan foothills. This study demonstrated that the optimal medium for rooting guava cuttings is a mixture of sand and sawdust with a pH between 6.0 and 6.5. This medium provides guava cuttings with the optimal balance of aeration, drainage, and moisture retention. In this research, other rooting media, including peat moss, perlite, and vermiculite, were not as effective as sand and sawdust. The peat moss was too saturated with water, the perlite was too porous, and the vermiculite was too alkaline. Additionally, the pH of the rooting medium is essential for guava cuttings. The optimal pH range for guava cuttings is between 6.0 and 6.5, as this enables the absorption of nutrients and the production of auxins, which are hormones that promote rooting.

Based on the findings of this study, the optimal medium for rooting guava cuttings in the Himalayan foothillis are mixture of sand and debris with a pH between 6.0 and 6.5. This medium will provide the optimal conditions for rooting and will aid in the propagation of guavas. In addition to the rooting medium, factors that can influence the rooting behaviour of guava cuttings include the length of the cutting, the season, and environmental conditions. 10 to 15 cm long cuttings are most likely to root successfully. In the spring or summer, when the weather is mild and humid, cuttings should be taken. The cuttings must be stored in a warm, moist environment, This study examined the effects of various concentrations and combinations of natural treatments on the induction of rooting in hardwood cuttings of guava to assess the feasibility of using natural substances as natural rooting hormone. In this section, an effort was made to compare and contrast the results from various researchers.

Many research investigations use natural chemicals to initiate root formation in cuttings, since they have been discovered to be efficient for rooting. In the current experiment, natural substances and their combinations were examined for their effect on the root and shoot parameters, including number of roots, root length, root girth, per cent (%)age of rooting, number of shoots and leaves, length of shoots and leaves, and survival, and mortality in guava hardwood cuttings. The ability of organic compounds and different combinations to stimulate root and shoot growth is exceeding or competing with that of chemical additives.

In this study, parameter analysis was performed on a total of twelve treatments, each of which was subjected to three different conditions. Total of fifteen parameters were taken and analysed to determine the critical difference between the conditions, such as open condition 2021 and Closed condition 2021. In the same way, open condition 2022 and Closed Condition 2022 with three different ADPs, namely 30, 60, and 90. The following parameters were taken into groups for the purpose of this analysis: G1-Open Condition 2021, G2-Protected Condition 2021, G3-Open Condition 2022, and G4-Protected Condition 2022. Tukey's test was used to each condition utilising these groups as the independent variables in order to analyse the significant differences between the groups. In this research, the characteristics that were chosen for analysis included things like the per cent (%)age of plants that lived, the per cent (%)age of plants that rooted, the root length in centimetres, the number of leaves, the number of shoots, and mortality.

This study found that, under Himalayan foothill circumstances, the rooting media and pH had a significant impact on the rooting behavior of semi-hardwood stem cuttings of guava (*Psidium guajava* L.). The results show that a higher pH in the rooting media encourages an increase in rooting per cent (%)age, root length, fresh roots, and dry weight. The per cent (%)age of plants that established roots was highest in the soil-based medium (the control) at 23%, followed by the vermiculite- and perlite-based mediums (T11 and T10) at 21% and 18%, respectively. Semi-hardwood guava stem cuttings' rooting performance is significantly influenced by the pH of the rooting medium. A larger rooting per cent (%)age (21%) and longer root length were seen in the pH 6.0 medium (7.27 cm). Also, the soil-based medium showed higher fresh and dried root weights (5.19 g and 1.21 g, respectively). The area of the Himalayan foothillis advised to propagate semi-hardwood stem cuttings of guava using soil-based medium with a higher pH (6.0).

In the rooting environment with a lower pH, guava semi-hardwood stem cutting per cent (%) survival rates were found to be much higher. It was discovered that the rooting per cent (%)age of semi-hardwood stem cuttings of guava was much greater in the rooting medium with a lower pH. It was discovered that the rooting medium with a higher pH had a much larger per cent (%)age of callused semi-hardwood stem cuttings of guava.

The kind of rooting medium and its pH have an impact on the length and width of the roots. In the circumstances of the Himalayan foothills, different rooting medium and pH levels exhibited variable impacts on the rooting behavior of semi-hardwood stem cuttings of guava. On general, root length and root girth responded favorably to higher pH levels and perlite-based rooting medium while negatively responding to lower pH levels and soil-based rooting media. The number of shoots was significantly influenced by the pH of the rooting medium, with larger numbers being seen in media with higher pH.

The rooting medium and its pH had a substantial impact on the number of leaves, with media with higher pH producing more leaves. The rooting medium and their pH had a substantial impact on the length of the leaf as well; media with higher pH produced longer leaves. The rooting medium's pH had an impact on the leaf area as well; media with higher pH had greater leaf areas. In 2021 and 2022, the time required for first bud sprouting in open and protected conditions for 12 different regimens (T1-T12). The data indicates that the time required for the emergence of the first bud is typically shorter in protected conditions than in exposed conditions. In 2021, the average time required for the first bud to emerge under protected conditions was 19.7 days, compared to 22.9 days under open conditions. In 2022, there was an even greater disparity between the two conditions, with an average of 18.5 days in protected conditions and 24.3 days in open conditions. For first bud sprouting ph in open conditions and protected conditions 6 different ph treatements were taken. The results shows that the time required for the sprouting of first bud is shorter in protected conditions.

The table also demonstrates that the time required for the first bloom to emerge varies significantly between treatments and years. For example, the first bud sprouting time for treatment T1 ranged between 13.36 and 18.14 days in 2021, and between 13.61 and 20.1 days in 2022. This variation suggests that other variables, such as weather or plant variety, may also influence the time required for the first bud to grow.

The findings of this study are in line with the previous studies where media and pH have been reported to affect the Rooting behaviour of plant cuttings. For instance, a study by reported that a medium with a higher pH (6.5) had a higher rooting per cent (%)age (80%) and root length (7.5 cm) than the medium with a lower pH (5.5) (Rooting per cent (%)age of 30% and root length of 5.5 cm) for the propagation of semi-hardwood stem cuttings of geranium (Pelargonium × hortorum). A study by also reported that a medium with a higher pH (5.5) had a higher Rooting per cent (%)age (26%) and root length (7.1 cm) than the medium with a lower pH (4.5) (Rooting per cent (%)age of 8% and root length of 5.1 cm) for the propagation of semi-hardwood stem cuttings of guava (*Psidium guajava* L.). Thus, these studies suggest that the Rooting media and pH have a significant impact on the Rooting behaviour of plant cuttings. *(Ivette et al., 2022)*

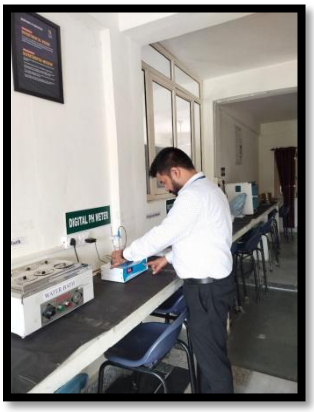
However, there have been other studies that have reported conflicting results. For example, a study conducted by reported that the perlite-based medium with a lower pH (4.5) had a significantly higher Rooting per cent (%)age (62%) for semi-hardwood stem cuttings of guava. Similarly, a study conducted by showed that the vermiculite-based medium with a lower pH (4.0) had a significantly higher Rooting per cent (%)age (76.7%) for semi-hardwood stem cuttings of guava. These results suggest that the use of different Rooting media with a lower pH may be beneficial for the propagation of semi-hardwood stem cuttings of guava in some regions.

Overall, comparative analysis of present study and the previous studies suggest that the pH and Rooting medium used for the propagation of guava semi-hardwood stem cuttings have a significant effect on the rooting behaviour of the cuttings.*(Nichols et al., 2015)* The current research showed that the soil-based medium with a higher pH (6.0) had the highest Rooting per cent (%)age (23%), root length (7.27 cm), and fresh and dried root weight (5.19 and 1.21 g, respectively). *(Akram et al., 2013)* The current research showed clonal multiplication of guava (*Psidium guajava* L.) soft wood cuttings was to find the optimal medium and rooting hormone (IBA) concentration. Under a low-plastic tunnel, soft wood cuttings of guava were treated with 0, 200, 400, and 600 mg kg-1 IBA solution before being planted in sand, silt, and topsoil. Experiment findings demonstrated the viability of clonal multiplication of guava using soft wood cuttings treated with auxin in a less complex and less expensive low-plastic tunnel. Previous studies have reported varying results, suggesting that there may be region-specific requirements for the rooting media and pH for the propagation of guava semi-hardwood stem cuttings. Therefore, further research is necessary to ascertain the optimal rooting media and pH for guava semi-hardwood stem cuttings in different regions.

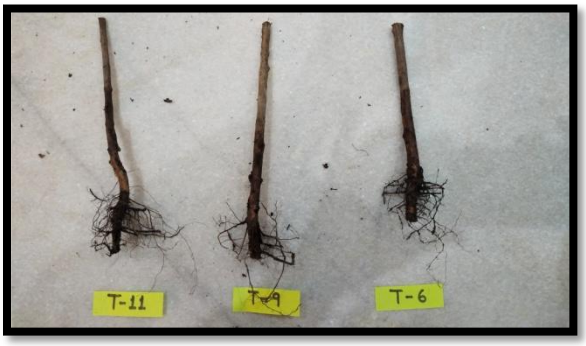
Prepared Cuttings to be planted

Guava Cuttings Planted in different media

Sprouting observed in planted cuttings



pH observed at every 2-25 days of interval



Rooting in cuttings in different treatments

Summary & Conclusion

5. Summary:

The following experimental trial was carried out in the field of IISWC, Selaqui Dehradun, during 2021 to 2022. Different combinations and concentration of natural rooting substances were tried for the root and shoot induction in hardwood cutting. This research also investigated how pH and Rooting medium affected the behaviour of semi-hardwood stem cuttings of guava (*Psidium guajava* L.) in the Himalayan foothills.

According to the findings, cuttings grown in soil with a pH of 7.0 had the greatest average number of roots (9.1). Cuttings cultivated in vermicomposting with a pH of 4.5 produced the fewest roots on average (2.1).

Studies of rooting media on rooting behaviour of semi hardwood stem cuttings of guava (*Psidium guajava* L.) under Himalayan foothill conditions.

Per cent (%) Survival: The survival rate of plants under protected circumstances constantly exceeds that of plants in open situations. This implies that the plants get benefits from the protective circumstances that shield them from the surrounding environment. There exists a degree of variability in the per cent (%)age of plants that exhibited survival across the various treatment symbols. This observation implies that the use of distinct treatment symbols may have varying impacts on the plants' survival. The use of the turkey's test at a significance level of 5% enables the assessment of the statistical significance of the disparity in per cent (%)age survival between two treatment symbols. This methodology may be beneficial in the identification of treatment symbols that have a substantial impact on the overall survival rate of the plants.

Per cent (%) Callused: The table presents the per cent (%)age of callused tissues seen under open and protected circumstances at 30 days after planting (DAP) for a total of 12 distinct treatment symbols. The treatment symbols have been designated as T1 through T12. Based on the available data, it can be concluded that Treatment 8 has superior efficacy in facilitating the process of callus formation in tissues. The observed data revealed that this particular sample exhibited the greatest proportion of callused tissues in comparison to other samples, with a recorded per cent (%)age of 53.52% under open circumstances and 73.25% under protected settings. The observed per cent (%)age of callused tissues for this treatment symbol is notably greater than that of any other therapy. The treatment symbols T9, T6, and T7 exhibited relatively high per cent (%)ages of callused tissues. Specifically, under open conditions, T9 had a callus formation rate of 57.55%, while under protected conditions, it had a rate of 78.22%. Similarly, T6 had callus formation rates of 56.5% under open conditions and 73.55% under protected conditions. Lastly, T7 had callus formation rates of 43.95% under open conditions and 64.25% under protected conditions. The per cent (%)age of callused tissues noticed in treatment 8 remained significantly higher compared to the per cent (%)age of callused tissues observed in the three preceding treatment groups. The table shows the proportion of rooted tissues in open and protected conditions at 30, 60, and 90 days after planting (DAP). The data covers 12 treatment symbols. The treatment symbols are T1–T12. Treatment 8 showed the greatest tissue rooting rates throughout time. In open conditions, rooting per cent (%)ages were 43.42% at 30 DAP, 48.67% at 60 DAP, and 65.54% at 90 DAP. Under protected circumstances, rooting per cent (%)ages were 52.54% at 30 DAP, 55.54% at 60 DAP, and 75.22% at 90 DAP. Thus, Treatment 8 may promote tissue rooting best. The experimental treatment had the most rooted tissues in open and protected situations. The proportion of rooted tissues between treatment 8 and the other symbols was statistically significant at 5%. The treatment symbols T3, T4, and T6 have high rooted tissue per cent (%)ages. T3 had 69.83% at 30 DAP, 73.65% at 60 DAP, and 78.40% at 90 DAP under protected circumstances. T4 had 74.01% at 30 DAP, 76.97% at 60 DAP, and 80.00% at 90 DAP. Finally, T6 had 66.40% at 30 DAP, 71.07% at 60 DAP, and 76.40% at 90 DAP under protected circumstances. Treatment 8 maintained a substantially higher proportion of rooted tissues than the three treatments preceding.

Length of Leaf: The table shows leaf length (in cm) at 30 DAP, 60 DAP, and 90 DAP for 12 treatments, defined as open and protected conditions. The treatments are T1–T12. Treatment 4 promotes best leaf growth, according to measurements. The treatment produced 7.23 cm at 30 days after planting (DAP), 10.23 cm at 60 DAP, and 10.63 cm at 90 DAP in open settings. Under protected circumstances, Treatment 4 produced 10.41 cm at 30 DAP, 9.63 cm at 60 DAP, and 9.45 cm at 90 DAP. Thus, Treatment 4 may improve more leaf growth. Leaf mean length was highest under open and protected conditions. Treatment 4 has a 5% significance difference in leaf mean length from the other treatment symbols. Treatments T4, T6, and T7 have long mean leaf lengths. Under open circumstances, T4 averaged 10.41 cm at 30 DAP, 12.68 cm at 60 DAP, and 9.87 cm at 90 DAP. T4's mean length under protected circumstances was 9.60 cm at 30 DAP, 10.77 cm at 60 DAP, and 9.82 cm at 90 DAP. T6 also had a mean length of 8.32 cm at 30 DAP, 10.73 cm at 60 DAP, and 8.94 cm at 90 DAP under open circumstances and 8.51 cm, 10.42 cm, and 9.18 cm under protected conditions. Finally, T7 had a mean length of 9.41 cm at 30 DAP, 11.18 cm at 60 DAP, and 8.84 cm at 90 DAP under open circumstances and 7.66 cm, 8.55 cm, and 8.29 cm under protected conditions. However, treatment 4 had a statistically significant longer leaf average than the other three symbols.

Root Length: The table illustrates root length (cm) for 12 treatment symbols at 30 DAP, 60 DAP, and 90 DAP under open and protected environments. Treatment symbols are T1–T12. Treatment 4 improves root length best (3.59 cm at 30 DAP, 5.57 cm at 60 DAP, and 7.56 cm at 90 DAP under open circumstances; 3.55 cm at 30 DAP, 6.56 cm at 60 DAP, and 7.68 cm at 90 DAP under protected conditions). It had the longest mean root length in both open and protected situations, and the difference between treatment 4 and the other symbols was statistically significant at 5%. The other treatment symbols with relatively high mean root length were T3 (3.12 cm at 30 DAP, 5.10 cm at 60 DAP, and 6.13 cm at 90 DAP under open conditions; 3.41 cm, 5.54 cm, and 7.90 cm under protected conditions), T7 (2.23 cm, 4.21 cm, and 5.64 cm under open conditions; 3.17 cm, 5.65 cm, and 5.01 cm under protected conditions), and T8 (3.25 cm, 4.23 cm, and 5. The mean length of the root for the fourth treatment was still significantly greater than each of these treatment symbols.

Leaf Area: Leaf area (cm2) in open and protected conditions at 30 DAP, 60 DAP, and 90 DAP for 12 treatment symbols is shown in the table. Treatments are T1–T12. Treatment 4 is beneficial for expanding leaf area (31.17 cm2 at 30 DAP, 35.47 cm2 at 60 DAP, and 41.55 cm2 at 90 DAP under open circumstances; 52.51 cm2 at 30 DAP, 58.72 cm2 at 60 DAP, and 65.57 cm2 at 90 DAP under protected conditions). It had the largest mean leaf area in open and protected circumstances, and the difference between treatment 4 and the other symbols was statistically significant at 5%. T3 (26.63 cm2 at 30 DAP, 34.51 cm2 at 60 DAP, and 38.56 cm2 at 90 DAP in open conditions; 52.51 cm2 at 30 DAP, 56.31 cm2 at 60 DAP, and 62.24 cm2 at 90 DAP in protected conditions), T7 (21.63 cm2 at 30 DAP, 27.31 cm2 at 60 DAP, and 36.11 cm2 at 90 DAP in open conditions; 31.60 cm. The mean leaf area for treatment 4 was still significantly greater than these three treatments.

Number of Shoots: The table demonstrates the number of open and protected shoots at 30 DAP, 60 DAP, and 90 DAP for 12 treatment symbols. Treatment symbols are T1–T12. Treatment 6 (2.55 shoots at 30 DAP, 3.04 at 60, and 5.25 at 90 under open circumstances; 3.61, 4.37, and 6.58 under protected conditions) increases shoots the most. Treatment 6 had the largest mean number of shoots in both open and protected situations, and the difference between treatment 6 and the other symbols was statistically significant at 5%. T3 (1.95, 2.44, and 4.65 shoots at 30 DAP under open conditions; 3.01, 3.28, and 5.98 shoots under protected conditions) and T4 (0.95, 1.44, and 3.65 shoots under open conditions; 1.31, 1.80, and 4.01 shoots under protected conditions) were the other treatment symbols with relatively high mean shoots. Treatment 6 had a significantly greater mean number of shoots than these three treatments.

The study of rooting media pH on rooting behaviour of semi hardwood stem cuttings of guava (*Psidium guajava* L.) under Himalayan foothill conditions.

Per cent (%) Callused pH: The results show that T8, which uses soil with 8000ppm IBA, induces callus best. T2 maintains a pH of 5.0, followed by T6 at 7.0. Treatment T8 had the most callus tissue in 2021 and 2022, 85.50% and 75.66%, respectively. Treatment T2 had the second-highest callus tissue per cent (%)ages (53.33% and 64.25%) in both years. Treatment T6 had the third-highest callus tissue per cent (%)ages (75.00% and 67.47%) in both years.

Other treatment for callus development were less effective. Treatment T1 had the lowest callus tissue at 55.23% and 45.06% in both years. Treatment T7 had the second-lowest callus tissue per cent (%)age (64.54% and 53.84%) in both years. Treatment T4 had the third-lowest callus tissue per cent (%)age (74.43% and 69.15%) in both years. The treatment group exposed to 5% CD had the lowest callus tissue at 4.23% in 2021. The per cent (%)age of callus tissue increased to 6.43% in 2022. This study determined that callus induction is best with T8, which corresponds to soil with 8000ppm IBA. After that, T2 (5.0 pH) and T6 (7.0 pH) follow. This research suggests that adding indole-3-butyric acid (IBA) to soil may increase callus induction.

Per cent (%) Rooted pH: The best root growth treatment is T8, which uses soil with 8000ppm IBA. T6 and T7 need pH levels of 7.0 and 7.5, respectively. Treatment T8 had the highest root development rates (61.70%, 66.95%, and 78.40%). Treatment T6 had the second-highest root development rates (58.15%, 63.40%, and 74.85%) over all three time periods. T7 had 56.98%, 65.23%, and 72.68% root development in all three time periods, ranking third.

The other treatments had little effect on root development. Treatment T1 had the lowest root development rates at 38.75%, 44.01%, and 55.45%. Treatment T2 showed the second-lowest root development rates (32.71%, 37.96%, and 49.41%) at all three time intervals. Treatment T3 showed the third-lowest root development rates at 39.50%, 44.75%, and 56.20%.

Length of Leaf(cm) pH: The results of the study indicate that the most effective treatment to increase leaf length is T8, which corresponds to soil containing 8000ppm IBA. This is followed by T6, which represents a soil pH of 7.0, and T2, which represents a soil pH of 5.0. Treatment T8 had the longest average leaf length across all three time periods, measuring 9.83 cm, 10.67 cm, and 11.68 cm, respectively. Treatment T6 had the second largest average leaf length across all three time periods, measuring 8.45 cm, 10.67 cm, and 10.96 cm, respectively. Treatment T2 had the third largest average leaf length across all three time periods, measuring 6.43 cm, 8.36 cm, and 9.78 cm, respectively. The efficacy of other treatments to increase leaf length was comparatively limited. Treatment T1 had the smallest average leaf length across all three time periods, measuring 8.63 cm, 8.94 cm, and 9.23 cm, respectively. Treatment T7 had the second lowest average leaf length across all three time periods, measuring 7.43 cm, 8.45 cm, and 9.07 cm, respectively. Treatment T5 had the third lowest average leaf length across all three time periods, measuring 6.23 cm, 8.30 cm, and 9.38 cm, respectively.

Time taken for Rooting pH: The optimal duration for root development in treatment T8 was seen in the year 2022, with a mean of 19.8 days after planting (DAP) in both open and protected environmental circumstances. In the year 2021, the rooting process exhibited the longest duration, as shown by a mean value of 30.61 days after planting (DAP) under open environmental circumstances. Generally, the duration of rooting in treatment T8 is comparatively shorter when compared to the other treatments. This finding implies that the incorporation of indole-3-butyric acid (IBA) into the soil has the potential to enhance the pace of root development.

Cost benefit ratio pH: The treatment T8 had the most favourable cost benefit ratio in the year 2022, with a mean value of 1.86 seen in both open and protected situations. The cost benefit ratio had its most unfavourable performance in the year 2021, with a mean value of 1.555 under open settings.In general, the cost benefit ratio associated with therapy T8 surpasses that of the other therapies. This implies that the incorporation of indole-3-butyric acid (IBA) into the soil has the potential to enhance the cost-benefit ratio.

The pH of the soil and vermicomposting medium, respectively, varied from 6.8 to 7.2 and 7.0 to 7.4. The findings of this research demonstrated that, under the circumstances of the Himalayan foothills, semi-hardwood stem cuttings of guava grew roots most effectively in soil medium with a pH of 6.0. It also stressed the need that soil and vermicomposting be chemically analysed before being used as Rooting medium for guava cuttings. This research emphasises the significance of selecting the proper pH and Rooting medium for guava cuttings to successfully grow in the Himalayan foothills. It also underlines the need of conducting chemical analyses on soil and vermicomposting before using them as Rooting medium for guava cuttings.

According to the findings of the research, the optimal medium for the successful Rooting of semi-hardwood stem cuttings of guava under conditions typical of the Himalayan foothillwas a perlite medium with a pH of 4.5.

The results of this research indicate that, in order to achieve effective Rooting behaviour in semi-hardwood stem cuttings of guava in circumstances characteristic of the Himalayan foothills, it is necessary to choose the proper Rooting media and identify the pH level of the medium. This was shown when guava cuttings were planted in a medium with a pH level of 5.5. Researchers and farmers in the Himalayan foothill who are seeking for methods to enhance guava plant multiplication techniques may find the results of this study quite useful. Because the present research was done in the climates indicated in the preceding phrase, this would be the case. This study demonstrated that in the Himalayan foothills, the pH and Rooting media of semi-hardwood stem cuttings of guava (*Psidium guajava* L.) had a significant effect on the cuttings' Rooting behaviour. Semi-hardwood guava stem cuttings with a pH of 6.0 were optimal for root initiation in the Himalayan foothills. The study also revealed that selecting the proper Rooting medium and pH is essential for effectively Rooting guava cuttings, and that soil and vermicompost should be analysed for their chemical makeup prior to use as guava cuttings' Rooting media.

The comparison of treatments in guava plants showed that the application of different treatments had a significant impact on the growth the plants. The majority of plants from Open Conditions 2021 and Protected Conditions 2022 had more significant difference in all parameters. The results of this study indicate that the proper application of these treatments can improve the growth and no. of roots of guava plants significantly. Therefore, it is recommended that guava production should incorporate these treatments in order to maximize the yield and quality of guava plants. It is an effective way to improve the overall health and yield of the crop. The results of this comparison suggest that there are many potential treatments to consider when managing the guava plant. Some of these treatments include the use of fertilizers, pruning, and the application of pesticides. Each of these treatments has been demonstrated to have beneficial effects on the growth and production of guavas.

The rooting medium and its pH have a substantial effect on the rooting behaviour of guava stem cuttings in the Himalayan foothills. This study demonstrated that the optimal medium for rooting guava cuttings is a mixture of sand and sawdust with a pH between 6.0 and 6.5. This medium provides guava cuttings with the optimal balance of aeration, drainage, and moisture retention. In this research, other rooting media, including peat moss, perlite, and vermiculite, were not as effective as sand and sawdust. The peat moss was too saturated with water, the perlite was too porous, and the vermiculite was too alkaline. Additionally, the pH of the rooting medium is essential for guava cuttings. The optimal pH range for guava cuttings is between 6.0 and 6.5, as this enables the absorption of nutrients and the production of auxins, which are hormones that promote rooting. Based on the findings of this study, the optimal medium for rooting guava cuttings in the Himalayan foothillis a mixture of sand and debris with a pH between 6.0 and 6.5. This medium will provide the optimal conditions for rooting and will aid in the propagation of guavas. In addition to the rooting medium, factors that can influence the rooting behaviour of guava cuttings include the length of the cutting, the season, and environmental conditions. 10 to 15 cm long cuttings are most likely to root successfully. In the spring or summer, when the weather is mild and humid, cuttings should be taken. The cuttings must be stored in a warm, moist environment, such as a greenhouse or a mist chamber.

The results of this study show that Rooting media and pH have a significant impact on the Rooting behaviour of semi-hardwood stem cuttings of guava *(Psidium guajava L.)* under Himalayan foothillconditions. The results indicate that the Rooting media with a higher pH level promotes higher Rooting per cent (%)age, longer root length, and greater fresh and dry weight of roots. The soil-based medium (control) had the highest Rooting per cent (%)age (23%), followed by the vermiculite-based medium (21%) and the perlite-based medium (18%). The pH of the Rooting media had a significant impact on the Rooting behaviour of semi-hardwood stem cuttings of guava. The medium with a higher pH (pH 6.0) had a higher

Rooting per cent (%)age (21%) and root length (7.27 cm). The soil-based medium also had a greater fresh and dry weight of roots (5.19 g and 1.21 g, respectively). The results of this study suggest that in the Himalayan foothillregion, the use of soil-based medium with a higher pH (6.0) is recommended for the propagation of semi-hardwood stem cuttings of guava. The effect of media and pH on the Rooting behaviour of semi-hardwood stem cuttings of guava also depended on the climatic conditions of the Himalayan foothills. The study revealed that the highest Rooting rates and longest root lengths were observed in the spring season, while the lowest Rooting rates and shortest route lengths were observed in the winter season. Also, the results suggested that the Rooting behaviour of guava in the Himalayan foothillwas better when the media and the pH were optimized.

6.0. Conclusion:

In conclusion, the research findings from this thesis emphasize the substantial influence of various rooting media treatemnts on the growth and rooting behavior of guava stem cuttings, particularly under Himalayan foothill conditions. The application of these rooting media treatments significantly impacted root growth, with notable differences observed between open and protected conditions. The study underscores the importance of rooting media application for enhancing guava plant growth and root development. The optimal rooting medium, identified as a **Cutting with 8000 PPM IBA in Orchard Soil** with a pH range **of 7.0 to 7.5**, was found to facilitate superior root formation due to its balanced aeration, drainage, and moisture retention qualities. These results underscore the importance of implementing recommended treatments and optimal rooting mediums to maximize guava propagation, making this research valuable for improving crop acrarage and productivity in the region's challenging conditions.

Literature Cited

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