COMPARATIVE ANALYSIS OF EFFECT OF SELECTED BIOFERTILIZERS ON THE GROWTH OF TOMATO PLANT

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By

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CERTIFICATE

This is to certify that the dissertation entitled **"Comparative analysis of effect of selected bio-fertilizers on the growth of tomato plant"** is an authentic work carried out by Ms. Navomi Sreenivasan (AB20B0T014) under my supervision guidance in the Department of Botany, St. Teresa's College (Autonomous), Ernakulam, in the partial fulfilment of the requirements for the award of the Degree of Bachelor of Science in Botany. I further certify that no part of this work in this project has been submitted for the award of any degree or diploma.

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ABSTRACT

As the world population is high, the increasing demands for food increased. So food production must also be increased. The objective of the present study is to investigate the growth of *Solanum lycopersicum.* The difference in the growth was tested between groups with or without treatment using organic fertilizer. The growth pattern of four plants with four control plants was analysed. The eight plants exhibited different growth with and without organic fertilizer. This result achieves the aim of the study of fast growing tomato plant.

INTRODUCTION

The term “Organic fertilizer” comprises material from animal or plant origin. It covers all soil amendments that add to the pool of soil organic matter, namely organic compounds and carbon (C). Soil organic matter improves the physical properties of the soil by improving its structure and water holding capacity and by preventing nutrient leaching. Since high temperatures promote the decomposition of organic matter in soils (FAO, 2006), the addition of organic matter to soils is particularly important for maintaining long-term soil fertility. Organic fertilizers usually also provide some measure of N, P and K, as well as varying amounts of micronutrients.

Tomato is a widely grown and versatile vegetable throughout the world for taste, colour, high nutritive value, and diversified use. Tomato fruit mainly contains fibre, phytonutrients, vitamin A, C, B complex, and carotenoids. Due to the restrictions on organic foods, not many fertilizers or growth promoters are available for organic tomatoes. Application of stimulators may contribute to enhanced growth, yield, and resistance against agricultural and horticultural plant pathogens, as well as the positive impact of content and activity of certain bioactive compounds. The quality of a vegetable can be characterized by features such as appearance, texture, safety, flavour and nutritional value. The appearance is the main characteristic because it defines the product commercialization value. The growing management of tomatoes, however, is highly influenced by pulverization of pesticides, so, there is the requirement for improving tomato production, and give consumers superior flavour and quality to reach their expectations. To produce organic food, it is necessary to use inputs and methods that improve the ecological equilibrium of natural systems. This happens because organic vegetable is grown without pesticides, herbicides, highly soluble fertilizers and genetically modified organisms. The value of the organic product is not only in the product itself, but also in its production process. Several researches show that the demand of organic agriculture has increased, because this kind of product is identified by the consumers as a healthy product. The total of organic land in the world has reached 43.1 million hectares in 2013, with 2 million organic producers. The total area under organic vegetable production has tripled, from 105 thousand hectares in 2004, to 305 thousand hectares in 2013. However, it represents only 0.5% of the total area of vegetables grown in the world. The United States, China, Mexico and Italy are the countries with the largest organic vegetable areas, all of them with more than 20 thousand hectares each. Despite the high growth, the organic farming comprises a small area of the total acreage in the world, probably due to the need for more information about the agronomic development of

crops under organic management, justifying the importance of a larger effort in research for new agricultural practices. Many approaches, including sensory, physical and chemical are currently in use to determine tomato quality.

A wide variety of soil textures can be used for tomato production. Ideal soil textures range from sandy to fine- textured clays as long as the soil is well drained (tomato roots will not tolerate being waterlogged), has good structure, and is well aerated. Planting dates can be determined by the type of soil a grower has. There are numerous insect pests that affect tomato crops. Control of pests requires continual monitoring and integration of biological and cultural practices. The best pest- management system is based on prevention rather than control. Consistent monitoring of tomatoes along with determining fast and correct prognosis is the key to managing pests before they get out of hand. Tomatoes are injured by pathogenic diseases caused by fungi, bacteria, and viruses, as well as abiotic diseases, which are caused by environmental and physiological disorders.

Tomato (Solanum lycopersicum) is one of the most important and widely consumed solanaceous fruit vegetables of the world. It gives a high yield within a relatively short period and it is economically attractive. Thereby, the area under cultivation of this crop is increasing day by day. In India, tomato occupied 760000 ha with a production of 18.39 MT (Anonymous, 2017). Tomatoes are an essential component of human diet for the supply of vitamins and minerals. Red tomatoes contain lycopene, an anti-oxidant that may contribute to protect against carcinogenic substances. Lycopene, the most important anti-oxidant has been linked with reduced risk of prostrate and various other forms of cancer as well as heart diseases (Adeniyi and Ademoyegun, 2012). Tomato consumption might be strongly protective against neurodegenerative diseases and beneficial for reducing cardiovascular risk associated with type-II diabetes. Organically grown tomato has found to be significantly influence the nutrient content as compared to tomato grown through conventional fertilizers application (Shankar et al. 2012).

The tomato crop has a great importance in the world, and its production, in 2013, reached 163.9 million tons and average yield of 34.7 tons per hectare. The tomato is classified as a functional food, for having good levels of vitamins, minerals, and especially lycopene, a carotenoid pigment that provides red colour and has antioxidant qualities.

OBJECTIVES

- To study the effect of banana peel extract on the growth of tomato plant.
- To study the effect of tea residue on the growth of tomato plant.
- To compare the effect of both bio fertilizers on the growth and development of tomato plants.

LITERATURE REVIEW

Organic fertilizers are generally thought to be an effective way to sustain soil fertility and plant growth. Banana peel solution and tea solution are said to have many plant growth elements in them. Chemical Composition of Banana Peel- It has been shown that banana peel contains many nutrients and minerals. Banana peels contain the three macronutrients i.e. Nitrogen, Phosphorus and Potassium, as well as many micronutrients, which promote the growth of garden plants from seed germination to blooms and fruits. Because of these nutrients, banana peels also help plants to resist against diseases Organic liquid fertilizer not only increases the growth medium of crops, but also accelerates the maturation and nutrient quality of the crops.

Organic fertilizers are naturally available mineral sources that contain moderate amount of plant essential nutrients. They are capable of mitigating problems associated with synthetic fertilizers. They reduce the necessity of repeated application of synthetic fertilizers to maintain soil fertility. They gradually release nutrients into the soil solution and maintain nutrient balance for healthy growth of crop plants. They also act as an effective energy source of soil microbes which in turn improve soil structure and crop growth. Organic fertilizers are generally thought to be slow releasing fertilizers and they contain many trace elements. They are safer alternatives to chemical fertilizers. However, the improper use of organic fertilizers leads to over fertilization or nutrient deficiency in the soil. Hence, controlled release of organic fertilizers is an effective and advanced way to overcome these impacts and maintain sustainable agriculture

Banana fruits are grown in practically every country across the globe, particularly in tropical and subtropical areas where they have been consistently growing and hence have made a significant contribution to the economies of those places (Zhang et al. 2005). Nevertheless, the waste produced by a single banana plant can account for up to 80% of the plant's entire mass. It is roughly calculated that 220 tons of by-products are generated per hectare annually (Shah et al. 2005), prompting an inventive approach to convert these readily available resources into value-added commodities.

As stated by Maat Van Uitert (2015), you may improve the fertilizing impact of banana peels by making fermented banana peels, banana peel tea, powdered banana peels, dried banana peels, or banana peel vinegar. You can also use banana peels to repel aphids (insects/pests) by putting them under the plant. According to Shala Munroe, banana peels are known to be

beneficial due to their nutrients (such as potassium), and you may use them to fertilize your potted plants

Without a doubt, fruit peel waste accumulates in large quantities on a daily basis in both domestic and industrial sectors. These peels were often discarded as waste by individuals. It's one of the most important issues that need to be addressed appropriately, especially at the industrial level (Jariwala and Syed, 2016) to ensure that the environment is pollutant free. Macro and micro nutrients, which are essential for plant growth, can be found in fruit peels (Ibrahim et al., 2016). Additionally, because of their mineral composition, which is necessary for plant growth, fruit peels are used as fertilizers to improve soil fertility and for micro biota enrichment.

As we all know, potassium and pectin are highly concentrated in bananas. We can also get magnesium, vitamin C, and vitamin B6 from it (Jessie Szalay, 2014). Moreover, banana peels are also a good source of potassium, and they can be used as a fertilizer for plants. Specifically, its peels include nutrients such as sulfur, calcium, salt, and, of course, manganese, which assist plants in initiating the process of photosynthesis. Banana peels, in layman's terms, offer numerous nutrients that improve plant growth and productivity, thus keeping your plants healthy (Kristi Stone, 2015). Containing these kinds of nutrients will keep your plants from wilting. In correspondence to that, it will enable you to do a Do-It-Yourself (DIY) banana peel in a jar with water and transfer it to a spray bottle, so you can just spray it on the soil so that plants can absorb its nutrients.

Tea plant is an important cash crop in tropical and subtropical areas (Meegahakumbura et al.). It is source of very refreshing and popular drink that is hot aqueous infusion of its dried leaves (KC et al.). Tea plant require appreciable amount of both macro and micro nutrients for proper growth and development. The minerals like nitrogen, potassium, phosphorous and magnesium are essential nutrients and their deficiency lead to the adverse effect on the yield and the quality of tea (Islam et al.,). These essential nutrients could be derived from fertilization. Fertilization, both organic and inorganic, is an important agricultural practice to increase crop yields, improve plant growth and development and maintain soil fertility by supplying nutrients to the plants (Qiu et a). The high fertilizer cost reduces the net returns and profits to the farmer. Also, the uncontrolled use of inorganic fertilizers leads to soil quality and water degradation through surface runoff and leaching. A better nutrient management strategy will be beneficial to farmers saving the high cost imposed on fertilizer and enable the production in a sustainable manner (Mokaya,).

Organic fertilizers can be used in place of chemical fertilizers because they have been found to improve soil fertility, water holding capacity, and structure, while chemical fertilizers may degrade the soil's physical properties and fertility. Contradictory results regarding effect on caffeine content was reported (Gao et al.,), (Tabu et al.,). It was reported that there was an increase in amino acid and decrease in catechins in tea due to increased nitrogen source. Chemical and organic fertilizers' effects on the growth of the tea plant and the quality of black tea have not yet been studied in Nepal. Thus, this study was performed to fulfil this gap and also this study helps to suggest the better fertilizer and their proper use to increase the quality and productivity of tea.

Tomato plant was used for the study. Tomato is widely used as a model crop for fruit development but also for diverse physiological, cellular, biochemical, molecular, and genetic studies. It can be easily grown in greenhouses or growth chambers. Plants grow, flower, and develop fruits well at daily light lengths between 8 and 16 h. The required daily light integral of an experiment depends on growth stage and temperature investigated. Temperature must be 10–35°C, relative humidity 30–90%.

Cultivated tomato belong to the *Solanaceae* family and the genus Solanum. They are not only the most popular vegetable crop but also the most cultivated vegetable worldwide (4.7 Million ha). Moreover, tomato is one of the most studied fleshy fruits because it is easy to grow, often used to explore its characteristics, or used as a model plant makes the use of tomato as an experimental plant even more promising.

MATERIALS AND METHODS

The plants belong to the Solanaceae family- *Solanum lycopersicum* was selected. These were selected due to their easy availability and easy germination. They were collected from a nursery in Aroor, Alappuzha. The seeds were examined to see whether there are diseased or malformed ones. Healthy seeds were separated out from the damaged ones for further experimental analysis.

The materials used for creating needed growth media are the following:

1. Grow bags
2. Soil
3. Tap water
4. Banana peel
5. Tea residue solution
6. Containers
7. Water can

The seeds were planted in two bags initially spaced at 10-15 cm distance. Seeds are sown at a depth of 2-3 cm and covered with fine layer of soil followed by light watering by water can. The beds were then covered with dry grass to maintain required temperature and moisture. The watering was done by water can as per the need till germination is completed. The covered dry grass was removed immediately after germination is complete. The seedlings with 5-6 true leaves were transplanted to the grow bags. Light irrigation was given 3-4 days after transplanting.

Preparation of Solutions:

1. Banana peel solution-

   Banana peels were cut into pieces and soak it for 2 to 3 days, allowing the minerals to extract. Banana peels contain lots of nutrients, including potassium, phosphorous, magnesium and calcium all of which are needed for good plant growth.
2. Tea residue solution-

   The residues of the tea were collected and soaked in water for 2-3 days. Then it is filtered. Tea powder contains four per cent nitrogen, along with

phosphorous and potassium, as well as other micronutrients that are beneficial for soil.

The two prepared solutions were applied to the two tomato plants with a gap of 8-10 days. The height, number of leaves and branches, first flowered plant were noted. The average height was calculated for growth analysis. The photographs of the plants were also taken each 10 days for future references.

OBSERVATION AND RESULTS

The comparative analysis of growth pattern of the two solution applied tomato plants with two control plats s n for 60 days. After two months, the experiment was concluded and the data was tabulated.

Plants grown with Banana solution

In *Solanum lycopersicum,* the average height of the plant was 30cm on the 20th day, which increased to 70cm on 60th day. In the control plant, the average height of the plant on 20th day was 15cm, which increased to 50 cm. The solution applied plant shows progressive increase in height. More number of leaves was formed in solution applied plant.

Plants grown with Tea residue solution

In *Solanum lycopersicum,* the average height of the plant was 50cm on the 20th day, which increased to 110cm on 60th day. In the control plant, the average height of the plant on 20th day was 31cm, which increased to 70cm. The solution applied plant shows progressive increase in height. In the case of tea remains more number of leaves was formed in the solution used plant.

Growth pattern of Banana peel applied plant and control plant:

Table 1: Height of the plants after treatment with banana peel solution

Days of growth	Height of plant (cm)
20 days	30cm
30 days	42cm
40 days	55cm
50 days	68cm
60 days	70cm

Figure 1: graph showing height of tomato plant after treatment with banana peel solution

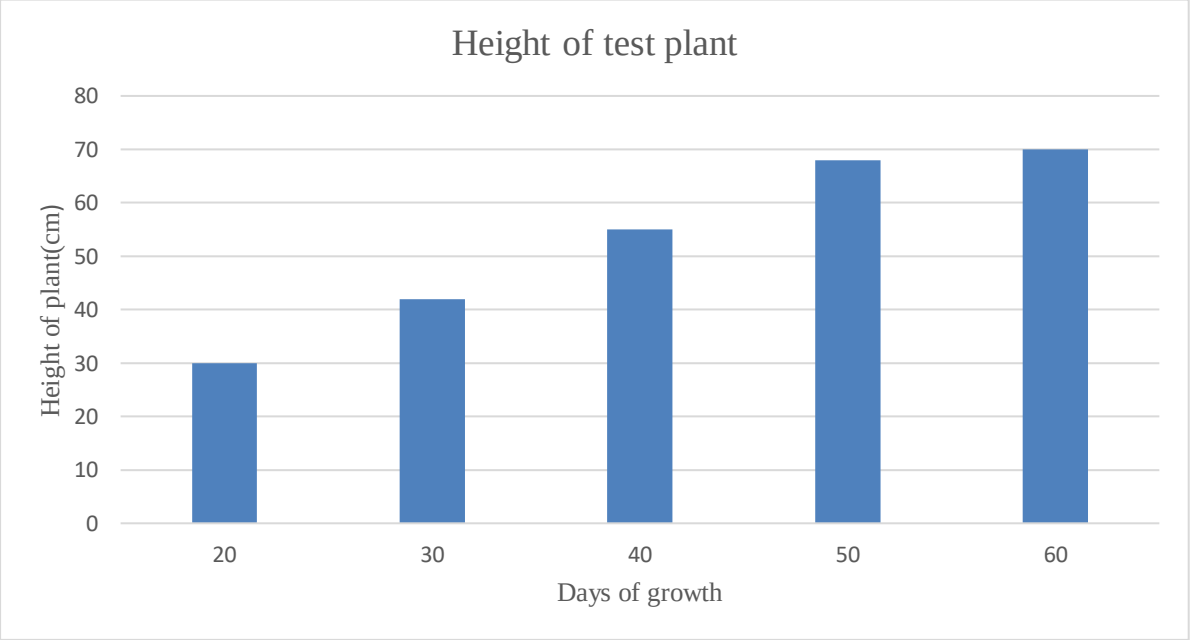

Table 2: Height of control plant.

Days of growth	Height of plant (cm)
20 days	15cm
30 days	20cm
40 days	31cm
50 days	42cm
60 days	50cm

Figure 2: graph showing height of control tomato plant.

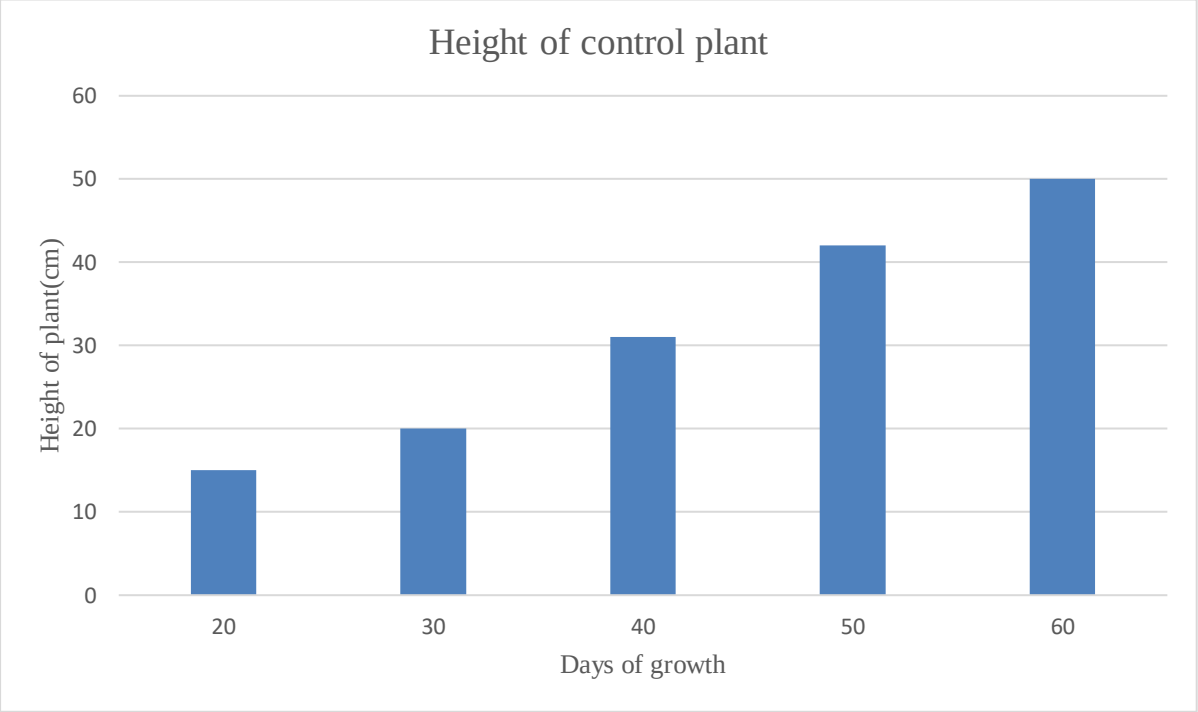

Table 3: Number of Leaves and Branches of test and control plant

Day of growth	Test plant		Control plant	
	No. of leaves	No. of branches	No. of leaves	No. of branches
20 days	40	0	25	0
30 days	51	0	32	0
40 days	60	0	40	0
50 days	72	1	52	0
60 days	80	2	60	1

Growth pattern of Tea residue solution applied plant and control plant:

Table 4: Height of the plants after treatment with tea residue.

Days of growth	Height of plant (cm)
20 days	50cm
30 days	73cm
40 days	85cm
50 days	90cm
60 days	110cm

Figure 3: graph showing height of tomato plant after treatment tea residue solution.

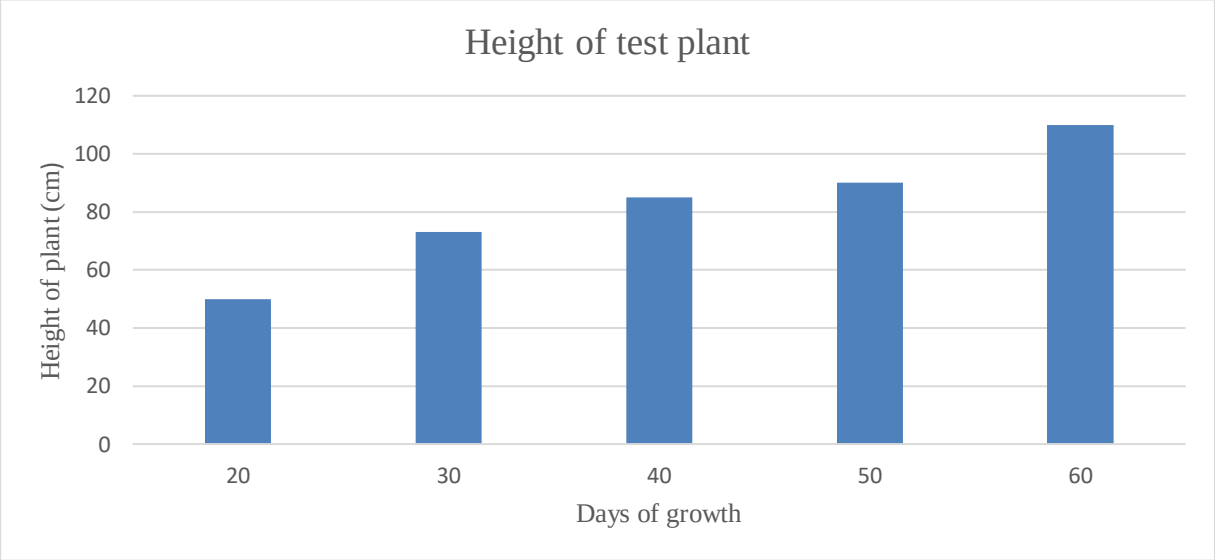

Table 5: Height of the control plant

Days of growth	Height of plant (cm)
20 days	31cm
30 days	40m
40 days	49cm
50 days	60cm
60 days	70cm

Figure 4: graph showing height of control tomato plant

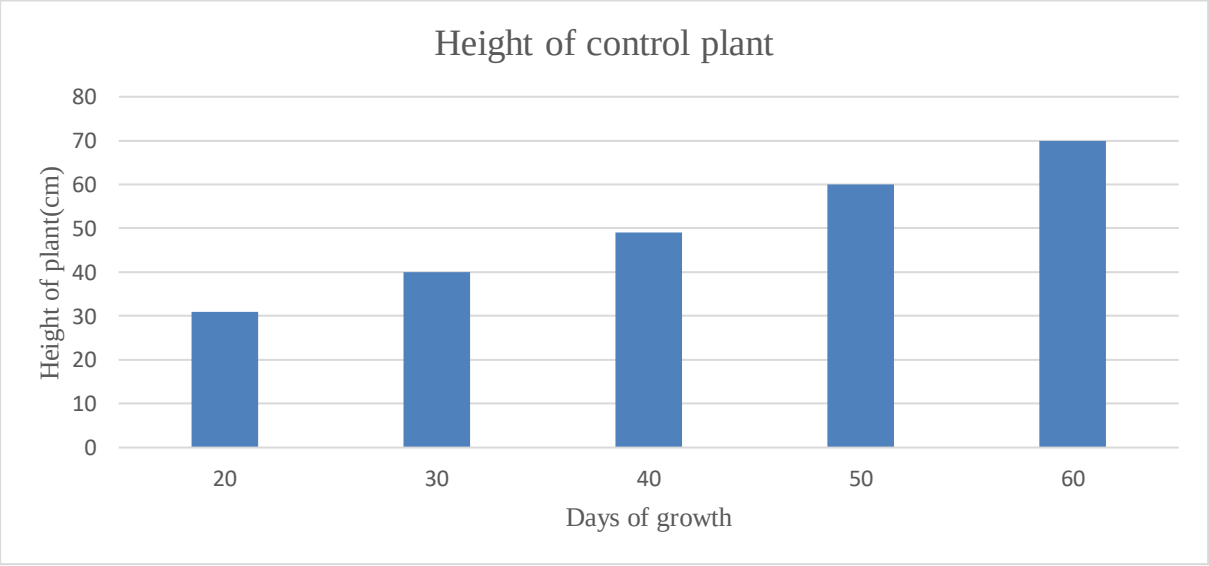

Table 6: Number of leaves and branches in test and control plants

Days of growth	Test plant (Tea residue solution applied)		Control plant (Tea residue solution not applied)	
	No. of leaves	No. of branches	No. of leaves	No. of branches
20 days	98	0	41	0
30 days	110	1	54	0
40 days	121	2	65	0
50 days	127	2	73	1
60 days	135	4	80	2

Figure 5: Bio fertilizers used. **(A)** Banana peel solution. **(B)** Tea residue solution

(A)

(B)

Figure 6: Plants after 10 days of growth. **(A)** Saplings applied with tea solution. **(B)** Saplings applied with banana peel solution.

(A)

(B)

Figure 7: Growth and development of Test plant applied with tea solution after 20 days.

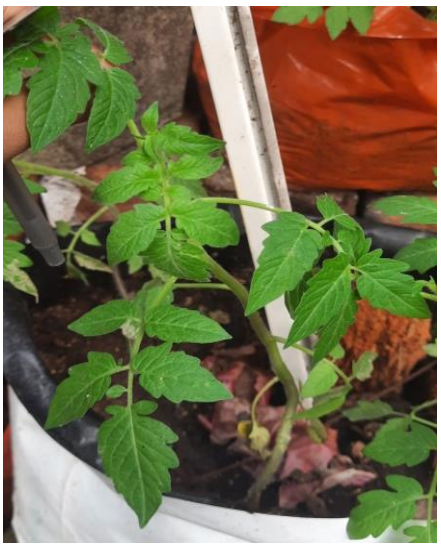

Figure 8: Growth and development of Test and control plant applied with banana peel after 20 days.

Figure 9: Flowering stage. **(A)** Plant applied with banana peel developed flower buds. **(B)** Control plant with flower buds.

(A)

(B)

Figure 10**:** Tomato plants treated with tea solution **(A)** Vegetative growth of the plant (**B)** Plant with flower buds **(C)** Plant with flowers.

(A)

(B)

(C)

DISCUSSION

In this work we have made a comparative study between eight tomato plants with and without applying organic fertilizers. This study was meant to show that using which medium of organic fertilizer the tomato plant grows easily for cultivation without using chemical fertilizers. Here we had used banana peel and tea residue for preparing organic fertilizers. Solution applied tomato plants showed faster rate of growth when compared to control plants.

Organic fertilizers are used to enhance soil quality and add nutrients essential for plant growth. In present research work soil is supplemented with different household organic waste as fertilizers for tomato plant. Plant growth parameters observed in the study consisted of plant height, number of leaves, branches and the flowering stage. The observations showed that the treatment using all the four solutions significantly affected the all plant growth. The results revealed that treatment with banana peel solution and tea solution resulted in minimum average days for germination of seeds.

Regarding the plant height after 60 days it was observed that the plant of treatment with tea solution shown greater plant height than the plant treated with banana peel. Banana peel has been considered as rubbish and smelly, apparently contains many chemical elements or compounds that are beneficial to plants. Banana peel waste belongs to wet organic waste. Organic fertilizer is beneficial to improve agricultural production both in quality and quantity, reducing environmental pollution, and improving land quality in a sustainable manner. Artificial chemical fertilizers can be easily washed out of the water and do not pollute rivers, lakes, and other water sources. In addition, the prolonged use of artificial chemical fertilizers in soils with low organic matter content can cause the soil to be quickly eroded by wind and rain. Organic manures rapidly becoming a necessary element of environmentally friendly and sustainable agriculture. Furthermore, banana peel fertilizer contains nutrients that aid in the natural and abundant growth of the plants. Banana peels serve as a pest repellent (Haider 2013; Hulbert 2014). It also helps your plants move nutrients and water between cells, it is because of the sodium present in it. Banana peel solution was prepared by soaking small pieces of peel in water for 2-3 days and the applied to the plants. Potassium rich banana peels are excellent for plants like tomatoes. It also contains calcium, which prevents blossom end rot in tomatoes. The manganese in banana peels aids photosynthesis, while the sodium in banana peels helps water flow between cells.

Tea residues are used, which is also an excellent organic fertilizer. The use of teas in agriculture is emerging because of their ability to suppress a wide range of both soil and airborne pathogens (Martin, 2014). In this regard, tea residues are viewed as potential alternatives to the use of common synthetic fungicides in response to the increasing need for environmental sustainability of farming and food safety (Pane et al., 2012). They release nitrogen naturally which helps balance out any carbon rich materials that may already be present. They are also rich in potassium and phosphorous.

Potassium maintains the ionic balance and water status within the plant. It is involved in the production and transport of sugars in the plant, enzyme activation, and synthesis of proteins. Potassium in tomatoes is also required for pigment synthesis, notably lycopene. High levels of potassium provide high yields in tomato crops. Calcium is a key component of cells holding the structure of cell walls and stabilizing cell membranes. Calcium enhances pollen germination; regulates some enzyme systems; and influences the growth and health of cells and conductive tissues. It is required for growth and yield and promotes the earliness of fruit development. The small amounts of calcium found in fruit are essential for the production of good quality tomatoes. Iron is required for nitrate and sulphate reduction and is associated with chlorophyll formation and photosynthesis. Manganese is an important micronutrient for plant growth and development and sustains metabolic roles within different plant cell compartments. Tomatoes *(Solanum lycopersicum*) are heavy nutrient feeding crops and require high amounts of nitrogen to maximize fruit production Magnesium is required for many processes including transfer of energy and protein synthesis. With 20-25 % of the plant's total magnesium localized in the chloroplasts, it is particularly important for chlorophyll production.

Tomato contains many health promoting compounds and are easily integrated as a nutritious part of a balanced diet (Marti et al., 2016). In addition to consuming the fresh fruits, consumers use tomatoes in processed products such as soups, juices, and sauces (Krauss et al., 2006; Li et al., 2018b). The nutritional importance of tomatoes is largely explained by their various health-promoting compounds, including vitamins, carotenoids, and phenolic compounds (Raiola et al., 2014; Liu et al., 2016; Marti et al., 2016; Li et al., 2018b).

Tomato has been recently gaining attention in relation to the prevention of some human diseases. This interest is due to the presence of carotenoids and particularly lycopene, which is an unsaturated alkali compound, appears to be an active compound in the prevention of cancer, cardiovascular risk and in slowing down cellular aging (Gerster, 1997; Di Cesare et al., 2012;

Abdel-Monaim, 2012). Lycopene is found in fresh, red-ripe tomatoes as all-trans (79–91%) and cis- (9–21%) isomers (Shi et al., 1999; Boileau et al., 2002; Abdel-Fattah and Al-Amri, 2012).

In the case of this experiment, organic fertilizer was used as an alternative to the chemical fertilizer. When organic fertilizer was used, it resulted in faster growth rate. The purpose of this study is to have a healthier and cheaper alternative fertilizer for tomato plant. The study aims to determine the function of the organic fertilizers that was prepared from easily available sources in tomato plant for fast growth than normal conditions.

In the present study, the organic fertilizers effect on tomato plant revealed that the treatments with banana peel solution and tea solution showed positive effects. The effect of organic fertilizers on tomato revealed that the treatment with tea solution showed higher plant height as compared to banana peel solution. It may be due to the fact that tea add nitrogen and carbon to the soil.

CONCLUSION

The demand for food is increasing all over the world due to the needs of the growing population. So the demand for food production is also increasing simultaneously. According to the data collected, the four plants in which the solution was applied show faster rate of growth when compared to control plants.

Among the two different growth media, tea residue solution was a good growth media with acceptable high amount of nutrients, including potassium, phosphorous, magnesium and calcium all of which are needed for good plant growth. It provides support to fast growth of the seedlings due to availability of better nutrition with water in root zone of seedlings. Therefore, the media of tea residue solution was more suitable than tap water because of the better physical properties and enhanced nutrient level. Results revealed significant differences in growth parameters among the two growing media when compared to control plants. The maximum growth parameters say, plant height was observed at plants grown with tea residue. Hence, tea residue solution was found as suitable growth media for growing of tomato seedling than tap water. The increasing demands of the developing world could be met only by new method of cultivation.

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