

**Efficacy of Vermicompost and Vermiwash on Growth parameters of  
*Solanum lycopersicum* L.**

**BY**

**SHANTHNI. J**

**(20PBO014)**

**Thesis submitted to the**

**Avinashilingam Institute for Home Science and Higher Education  
for Women, Coimbatore-641043.**

**In Partial Fulfillment of the Requirement for the  
Degree of Master of Science in Botany**

**May 2022**

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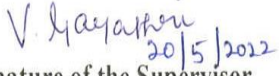
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Signature of the Head of Department

  
Signature of the Supervisor

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## ACKNOWLEDGEMENT

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# INTRODUCTION

## REVIEW OF LITERATURE

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# CHAPTER 1

## INTRODUCTION

Vegetables form a major part of the daily life for most of the people in their healthy diet. Vegetables grow faster and they provide high yield in both quality and quantity if grown organically. These Vegetables can be cultivated through organic farming using organic fertilizers obtained using beneficial microorganisms. By the revolution made in Vermiculture studies, it came to the point that the organic wastes which are eaten by earthworms turn into a nutritive “Organic fertilizer” and using them we can produce chemical and pesticides free safe food both quantitatively and qualitatively (Sujit Adikary, 2012). The poor manure management may lead to the contribution of eutrophication of surface water, ground water and coastal marine ecosystem. For the domestic and household solid waste, the best practicing method is vermicomposting. The organic waste management is done by using vermicomposting technology (Sunil Kulkarni, 2017). The Vermicomposting technology helps in the organic waste management. Vermicomposting have become the sustainable technology which includes the production of organic fertilizers and reduction in the use of chemical fertilizers (Shristi piya *et al.*, 2018). Composting and vermicomposting are the two best known processes for the biological stabilization of solid wastes. However, composting reduces agronomic value of compost and contributes to greenhouse gas emission due to nutrient losses during compost making. Moreover, composting requires human labour or fuel in order to turn the compost heap to ensure aeration. On the other hand, earthworm in Vermicomposting process serves as an agent for turning, fragmentation and aeration of the manure; therefore, it drastically increases the rate of microbial activities.

### WHY VERMICOMPOST?

Vermicompost is the major product obtained through aerobic decomposition and earthworm digestion using micro and macro-organisms at room temperature. Vermicomposting or worm composting is rich in soil amendment, plant nutrients and beneficial microorganism.

The two most popular benefits of vermicomposting are (1) diverting organic residuals from landfill and decreasing trash collection fees (2) turning waste materials into resources (Rick carr, 2016)

## **GENERAL CHARACTERISTICS OF VERMICOMPOST**

The excreta of the earthworm (Vermicompost) have the capability of improving the nutrient status and the soil health. The Vermicompost is obtained by converting the farm wastes, kitchen wastes, market wastes, biowastes of agro based industries, livestock wastes by passing through the worm-gut to get the nutrient rich material (Sujit Adikary, 2012). The vermicompost has the capability of increasing the soil fertility, physical, chemical, biological properties that contributes the enrichment of soil (Yvonne Indrani Ramnarian and Abdullah adil-lydiaori, 2018).

## **CHARACTERISTICS OF VERMIWASH**

Vermiwash is a liquid fertilizer which is brown in colour, it is obtained as the water passes via worm culture column. Vermiwash is used as foliar spray as it contains maximum nutrients. Vermiwash contains more beneficial microbes which helps in plant growth. Vermiwash contains sugars, phenols and amino acids (Sri Gayathri, 2010).

## **BENEFITS OF VERMIWASH**

Vermiwash is a natural fertilizer prepared using biodegradable organic waste. It acts as a disease resistance and pest control in plants. It helps in producing good yield and initiating flower production. Vermiwash helps in inhibiting the mycelia growth of pathogenic fungi. Vermiwash acts as a bio-pesticide when diluted with 10% cow urine or been extract or garlic extract (Vijayalakshmi kaviti, 2020).

## **VERMICOMPOSTING**

Vermicomposting is the biotechnological process of composting organic wastes which involves the conversion of complex product into simple fragmented particles using certain species of earthworm to get a better product. This process involves utilizing the microorganism and earthworm will be active at 10°C to 32°C (mesophilic process). Through this process the earthworms can transform the garbage into “gold” (nutritive vermicompost) (Sujit Adikary, 2012). This process takes short period of time as the material passes through the earthworm gut and the resulting product is rich in microbial activity and plant growth regulators. (Tamanreet Kaur, 2020).

## **NUTRIENTS IN VERMICOMPOST**

Vermicomposting not only has the efficiency in managing solid waste, but it also has many beneficial roles in providing nutrients to soil and plant growth (Tamanreet Kaur, 2020). Vermicompost is the amazing soil additive which is made from digested compost. It is more valuable and contains higher nutrients and microbial life as it is a worm casting. It is found that worm castings contain up to more than 5 times the plant available nutrients found average potting soil mixes. It is analyzed and found to be that the phosphorus gets converted into plant available form while it passes through the gut of worms. To obtain a healthy and productive plant, the combination of nutrients and microbial organisms are necessary. Vermicompost also has the capability of increasing the water retention capacity (Sujit Adikary,2012). The nutritive materials like NPK, humus, nitrogen-fixing bacteria, actinomycetes are obtained from the earthworm excreta (vermicast) (Tamanreet Kaur,2020).

## **WORMS AND THEIR BIOLOGICAL FEATURES**

The Earthworm which are randomly found in garden are not suitable for Vermicomposting. The soil dwelling worms cannot produce large amount of food wastes and they cannot reproduce in confined space. The worms such as red worms and red wigglers are preferred more as they can reproduce rapidly. The most common species for Vermicomposting are *Eisenia fetida* and *E. andrei* (Rick carr, 2016). Most of the Earthworms are found to be in the soil except some species like *Pontodrilus burmudensis*, which lives in estuarine water. The species of earthworm vary greatly in length *Microscotex phosphoreus (duges)* is around 20mm long, *Drawida grandus (bourus)* is 1m in length. The Earthworms feed on decaying organic matters like leaf and plant material found on soil (Gajalakshmi and Abbasi, 2004). Earthworms can also be differentiated into omnivorous and carnivorous. Most of them are omnivorous *Agastrodrilus*, a carnivorous genus of Earthworms found in the ivory coast of Africa has been reported to feed upon other earthworms of the family Eudrilidae (Sujit Adikary, 2012). Earthworms and invertebrates belong to the phylum Annelida and class Oligochaeta (Gajalakshmi and Abbasi, 2004). Earthworms belong to the family Lumbricade, they are hermaphrodites, but self-fertilization is rare. Under favourable condition, one pair of earthworms could produce approximately 100 cocoons in 6 weeks to 6 months. The incubation period is roughly about 3-5 weeks. They have the ability of regenerate body segments, which are lost by

accident (Sujit Adikary, 2012). The fully developed Earthworms can be separated and dried in an oven to make a “worm meal” which is rich in protein. *E. eugeniae* is a manure worm which is found and extensively used in North America and Europe for the vermicomposting due to its high rate of growth and reproductive ability (Gajalakshmi *et al.*, 2001). Few years back, this type of species is brought to India, and it progressively started increasing the application of vermicomposting of animal manure and other forms of biomass (Garg *et al.*, 2006).

## **MULTIPLICATION OF WORMS**

In 1:1 ratio, the Earthworms can be multiplied in a mixture of cow dung and decaying leaves that are kept in a cement tank which has proper drainage facilities (Sujit Adikary, 2012). The culture of the worms needs to have a mixture of 50 worms per 10 kg of organic wastes with dried grass or straw in a wet gunny bag. This process should be undertaken under shade. The moisture level should be maintained occasionally by sprinkling water. Within 1-2 months, the worms multiply 300 times which can be used for the scale Vermicomposting (Garg *et al.*, 2006). Manna *et al.*, (1997) studies has been shown that maize straw might be the most suitable feed material compared to soybean (*Glycine max*) straw, wheat straw and chickpea (*Cicer arietinum*) straw.

## **HARVESTING OF VERMICOMPOST**

Harvesting is collecting the final product after the process of composting. The final product will be black or dark brown and is called crumbly worm compost. It is necessary to change the bedding twice a year after harvesting the compost and it helps in maintaining the health of the worms. Harvesting can be done by spreading the sheet of plastic under a bright light or under sunlight. The bedding materials are divided into several heaps on the sheet. Due to the bright light, the worms will move away from the light to the centre of each heap. Later the worms can be collected for reuse (Sujit Adikary, 2012).

## **PRECAUTIONS DURING THE PROCESS**

The precautions to be taken during Vermicomposting are follows as:

- The African species of Earthworms, *Eisenia fetida* and *Eudrilus eugeniae* are very much suitable for the preparation of Vermicompost.

- Aromatic leaves like Eucalyptus and pine leaves must be avoided for preparing Vermicompost as these leaves may harm the Earthworms.
- Grass leaves or vegetable peelings must be used in preparing Vermicompost. Eggshells, meat, bone, chicken droppings etc., are not suitable for preparing Vermicompost.
- Kitchen wastes like, tobacco leaves, onion, garlic, chilli etc., are not suitable for preparing or rearing earthworms.
- The Earthworms must be protected against birds, termites, ants and rats.
- Moisture must be maintained.

## **BENEFICIAL ROLES OF VERMICOMPOST**

High percentage of humus can be obtained from red worm castings (Applehof *et al.*, 1996). Humus helps in forming clusters, which helps in the passage of air and improve its capacity to hold water (Ghabbour, 1973). The worms regenerate the soil and helps in improving water penetration in such soils by over 50% (Bhat and Khambata, 1996). A study from US indicates that 10,000 worms in a farm plot provides the same benefit as three farmers working 8 hours in shift all year round with 10 tons of manure applied in plot (Li, 2005). The humus contains lots of humic acid which helps in binding calcium, iron, potassium, sulphur and phosphorus (Canellas *et al.*, 2002). Humic acid contains nutrients which is readily available to plants during the requirement. The small amount of humic acid % is also responsible for the plant growth (Canellas *et al.*, 2002). It is believed that humus that helps in preventing the harmful plant pathogens, fungi, nematodes and bacteria (Nielson, 1965). The Vermicompost can fight against soil-borne plant disease such as root rot. The humus plays an important role in increasing the permeability and water retention capacity, contributing to better plant health.

The concentration of nitrogen is higher in Vermicomposting than in aerobic compost piles (Ayre, 2007). Castings are the substances released by earthworms; they provide essential nutrients for the growth of plants. They slowly dissolve to avoid immediate nutrients leaching. Vermicomposting also possesses very high process of porosity ‘aeration’, drainage and water

holding capacity than the conventional compost and this again are due to the humus content (Suhane, 2007).

The main objective of the present study is to analyze the Efficacy of Vermicompost and Vermiwash on the Growth parameters of the test plant, *Solanum lycopersicum* L.

## CHAPTER 2

### REVIEW OF LITERATURE

Literature related to the organic farming using Vermicompost and Vermiwash that is relevant to the present study are reviewed and presented in this chapter.

Akram Feizabadi *et al.* (2021) treated rapseed with Vermicompost under drought stress. Application of Vermicompost increased plant height, silique number per plant, biomass and grain yield. It also increased palmitic acid and linoleic acid concentration. Vermicompost is an effective fertilizer and helps in improving soil properties and nutrient availability for plants. So, it is advised to compensate and decline the plant yield imposed by drought stress.

Ali Mohal Yaloo *et al.* (2021) carried out experiment on controlling pest in crops by applying Vermicompost, instead of inorganic pesticides. The application of Vermicompost not only increased crop growth and yield, but also controlled diseases and pests. Vermicompost tea has potential to protect the plant from diseases and reduce available sites for pathogen infection or increase microbial diversity that can kill harmful pathogens.

Mohsen Ebrahim *et al.* (2021) conducted experiment on egg plant using Vermicompost, combination of biochar and vermicompost to evaluate growth, yield and water use efficiency under deficit irrigation. The experiment was done in split-split plot based on complete block design with three replications under open field conditions. The soil amendment with vermicompost, pistachio biochar and 100% PWR showed the best plant growth. The efficiency of plant was maximum under mixed application of vermicompost and pistachio biochar at 50% PWR. Combination of pistachio biochar and vermicompost at 100% PWR resulted in highest leaf concentration of Nitrogen, Potassium, Iron, Phosphorous and Manganese. Results revealed that under normal and particularly water deficit conditions, Vermicompost and biochar increased egg plant growth yield.

Muhammad Younas *et al.* (2021) have proved on application of Vermicompost *Prosopis cineraria* and FYM in maize higher growth, nutrient uptake, quality and maximum yield potential.

Vijantie awadhperasd *et al.* (2021) carried out research work in tomato plant by combining Vermicompost and Vermiwash as biofertilizer. They showed that, the Vermiwash speeds up the lifecycle of the plant growth. Vermicompost had a positive effect on the plant growth parameters and production of plant.

Guzman-albores *et al.* (2020) conducted experiment to evaluate the effect of different Vermicompost application on growth, protein and chlorophyll content in leaves of *Moringa oleifera* under water stress and deficit conditions. Protein content increased when Vermicompost was added at rate of 500kg N ha<sup>-1</sup> in both water logging and deficit conditions.

Lan huang *et al.* (2020) carried out experiment on biochar, Vermicompost and commercial peat-based substrate by mixing three substrates in containers to estimate the growth parameters.

Fazilet Parlakova Karagoz (2019) carried out studied using PGPB and showed that autoclaved Vermicompost + PGPBs promoted better performance as compared to other treatments. Autoclaved Vermicompost can be a better option in *Gladiolius* cultivation along with PGPB.

Yuvaraj *et al.* (2019) carried out experiment to decompose poultry litter amended with cow dung and *Tectona grandis* leaf litter into Vermicompost using *Drawida sulcata*. Plant growth study conducted using *Abelmoschus esculentus* by amending soil with different concentrations of Vermicompost showed highest growth in 50% and 75% Vermicompost supplementation. This confirms that *D. sulcata* an epigeic earthworm can be used for in situ degradation of poultry litter.

Govindapillai seenan Rekha *et al.* (2018) conducted experiment on chilly plant and observed better growth and improvement of soil quality. Comparing the plant grown underplant growth regulators PGR, the plant treated with Vermicompost showed enhanced growth rate, therefore Vermicompost is considered as good natural fertilizer for cereals and vegetable crops.

Ramnarian *et al.* (2018) have studied the effect of Vermicompost as a biofertilizer on the plant growth parameters of pak choi (*Brassica rapa* var. chinensis) plant treated with Vermicompost that possess similar effect with those treated with cow manure. Most of the soil

parameters except Mn and Fe concentration increased slightly after application of Vermicompost even after harvesting.

Saad Abou-el-hassan (2018) concluded that using “Giza 20” cv. with Vermicompost + PGPR produce good quality of onion similar to that produced with mineral fertilizers with high quality bulbs at harvest and during storage. High concentration of Vermicompost or 50% compost + 50% Vermicompost + PGPR produce low yield but with high quality bulbs at harvest.

Shristi piya *et al.* (2018) have shown that Vermicompost can be used as organic fertilizer which improves the soil quality as well as plant growth and production. Efficacy on soil quality and PGP greatly depends on raw material used for its production with spiking of earthworm friendly wastes to few probable toxic wastes like sewage.

Sifolo S. Coulibaly *et al.* (2018) have compared the raw cattle dung and Vermicompost from cattle manure and shown an increase in the mineral nutrient content in leaves, seed and roots of *L. siceraria* using Vermicompost from cattle manure. It also decreases the heavy metal concentration in different parts of the plant.

Makkar *et al.* (2017) applied Vermicompost to *Linum* plant which showed enhanced growth of both vegetable and reproductive phase of the plant. Vermicompost and foliar spray (Vermiwash) has synergistic effect in *Linum* plant.

Suparno *et al.* (2017) have found that it is possible to convert urban waste into Vermicompost using three types of worms (*Lumbricus rubellus*, *Lumbricus terrestris* and *Eisenia fetida*). From the analysis they have concluded that *Lumbricus rubellus* has the highest influence in production of more amount of Vermicompost.

Adeyemi O Aremu *et al.* (2015) studied quantitative evident of CKs, 18 GAs and 6 BRs in VLC. The Vermicompost leachate enhanced the growth and yield and improved the stress response to various biotic and abiotic stresses observed in VLC -treated plants.

Marc zucco *et al.* (2015) conducted experiment on application of Vermicompost to tomato for studying growth responses of three different classes of soils (loamy sand, silt loam and silty clay). Application of Vermicompost rates (10.4 and 0.8 g/g) produced taller plants with more leaf and flower numbers, higher leaf chlorophyll content, greater plant biomass and more

total leaf area compared to low Vermicompost applied soil. Finally sandy soil with Vermicompost amendments generally increased tomato plant growth parameters when compared to the clay and loam soils, with loam soil generally providing least.

Hossein Moradi *et al.* (2014) made several long-term studies and proved that addition of compost improves physical properties and improves soil water holding capacity.

Thu Doan *et al.* (2013) conducted one year experiment under greenhouse condition with a maize – tomato-maize cycle. Compost and Vermicompost modified soil chemical properties leading to high carbon and nitrogen, high pH and CEC, lower available phosphorous, ammonium and nitrite than in control. The application of Vermicompost has same effect on first maize planting.

Amir khan and Fouzia ishaq (2011) conducted experiment on the vegetable crop *Pisum sativum* by the application of different composts (Vermicompost and pitcompost) and garden soil (control) to find the effect of these composts on plant growth. It was found that Vermicompost was rich in micro and macro nutrients and have the potential to improve plant growth than pit compost and garden soil. The results indicate that Vermicompost increased the growth of *Pisum sativum* plants in a very short period.

Amir khan and Fouzia ishaq (2011) have demonstrated that the growth of pea plant in Vermicompost soil was maximum with a greater number of leaves, length of root, height when compared to plant grown in garden soil and pit compost. Worm mucus present in the Vermicompost helps in preventing nutrients from washing away and hold moisture better.

Gederts levinsh (2011) made a study to test the effects of Vermicompost and Vermiwash on seed germination and seedling growth of different vegetable crops. The Vermiwash showed a positive effect on growth of bean and pea seedlings. Finally, it was reported that vermicompost and Vermiwash contain a greater number of active substances of both phenolic and humic nature each with own dose and genotype-dependent effect of seed germination and early stages of seedling development.

Goutam Kumar ch *et al.* (2011) conducted field trials using different fertilizer with equal concentrations of nutrients to determine the effect on different growth parameters of tomato plants. Six types of plots were prepared, among the six, the plot in which the plants were

Vermicompost supplemented with N, P, K showed better results in terms of number of branches and number of fruits/plants.

Hodson and Cracked (2011) have shown *Lumbricus rubellus* is the earthworm species that is considered as major waste eater. They are used worldwide for waste degradation and successfully used in the ecology management of urban organic waste.

Narkheda *et al.* (2011) conducted experiment on the effect of chemical fertilizer and Vermicompost on the growth of *Capsicum annum* crop. Urea was used as chemical fertilizer for the comparative study with Vermicompost. Five concentrations were maintained at each plot. There was an increase in plant height, leaf length in treated with Vermicompost. Results revealed that and plots Vermicompost acts as growth promoter for *Capsicum annum* crop.

Agarwal *et al.* (2010) have carried out studies on the production of vegetable crops like tomato (*Lycopersicon esculentus*), egg plant (*Solanum melongena*) and okra (*Abelmoschus esculentus*) and obtained good result on application of Vermicompost. There was an excellent growth in the vegetable crop with more flowers and fruits. But later it was observed that less incidence of “yellow vein mosaic, colour rot” and powdery mildew diseases in worm and Vermicompost applied plants.

Rajbir singh *et al.* (2010) conducted experiment to determine the effect of Vermicompost on plant growth, fruit yield and quality of “chandler” strawberry. Results revealed that with the increase in dose of Vermicompost, there was increase in plant growth, yield and quality parameters of strawberry. Fruit harvested from plant possess high TSS, ascorbic acid content and low acidity. Results showed that Vermicompost had significant role in producing healthy fruits and thereby increasing the marketable fruit and yield with better quality parameters.

Theunissen *et al.* (2010) found that Vermicompost contains plant nutrients such as N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu and B helps in giving positive effect on plant nutrition, photosynthesis and the chlorophyll content of the leaves. The Vermicompost contributes to the plant health, as it promotes the production of phenolic compounds such as anthocyanin and flavonoids which helps in improving plant quality and act as deterrent to pests.

Cristina Lazcano *et al.* (2009) carried out study using Vermicompost to produce tomato plant in nurseries. The proportions used were (0%, 10%, 20%, 50%, 75%, 100%). The

Vermicompost served as an adequate substrate for tomato plant growth. The low doses of Vermicompost (10% and 20%) produced significant increase in aerial and root biomass of tomato plants. They improved the plant morphology (higher number of leaves and leaf area, increased root volume and branching).

Glenda sallaku *et al.* (2009) have reported that along with sphagnum peat, Vermicompost serves as an appropriate growing media for vegetable seedling propagation. During nursery period it provides high growth rate and high dry matter. Application of Vermicompost increased the primary nutrients in soil.

Guerrero (2009) made a study at CSIRO Australia and shown that earthworm (*Aporrectodea trapezoids*) increased the growth of wheat crops (*Triticum aestivum*) at the rate of 39%, grain yield by 35%, protein value of grain by 12% and has great resistance in controlling the disease.

Marta Rivera and Edwardo's Wright (2009) conducted research on Vermicompost as plant growth promoter and disease suppressive substrate in Latin America. Most of the researchers deal with Vermicompost characterization and its uses as substrate for crop growing. Research was conducted in green house and field, including seedling plots, micro propagated plantlets and adult plants. It was proved that they help in improving the substrate quality and provide great commercial aptitudes to the crop production.

Surindra Suthar (2009) studied the impact of Vermicompost and Farmyard Manure (FYM) along with NPK fertilizers on the garlic crop (*Allium sativum* L.). Six experimental plots were maintained. The results obtained It is suggested that Vermicompost manures may be the potential source of plant nutrient for sustainable crop production.

Uma and Malathi (2009) carried out study on the efficacy of Vermicompost produced from organic waste over chemical fertilizer by applying it to *Amaranthus* species. The Vermicompost composition obtained was 120.5 ppm of nitrogen, 18.39 ppm of available potassium. By applying Vermicompost, the net production obtained from *Amaranthus* was 4kg/plot (8.25 sq. ft./32 days). The result revealed that the vermicompost is responsible for the increased growth and yield of *Amaranthus*.

Gr Bachman and Metzger (2008) investigated Vermicompost at different ratios in the production cycle of tomato, marigold, pepper and cornflower. The application of Vermicompost had little influence on pepper and cornflower seedling growth, but there was no effect on the germination of seeds at any species. After transplantation of tomato, French marigold and cornflower there was greater increase in plant growth when the media was amended with vermicompost compared to the control media.

Karmegam N. Daniel T (2008) conducted experiment on hyacinth beans (*Lablab purpureas*) by applying Vermicompost and chemical fertilizer and shown high growth and yield parameters such as total chlorophyll present in leaves, dry matter production, flower appearance, length of fruits and number of fruit per plant, dry weight of 100 seeds, yield per plot and yield per hectare were significantly higher in plots that received Vermicompost in combination with chemicals.

Singh *et al.* (2008) have studied on increase in the yield of Strawberries upto 32.7% by the application of Vermicompost.

Federico Gutierrez Micoli *et al.* (2007) carried out experiment on growth, productivity and chemical characteristics of tomatoes (*Lycopersicum esculentum*) using vermicompost as soil supplement. Six treatments were applied in the proportion of 0:1, 1:1, 1:2, 1:3, 1:4 and 1:5 (v/v). Addition of Vermicompost increased the plant height, but it had no effects on number of leaves. Yields of tomato were greater in relationship with Vermicompost. Vermicompost increased the tomato yields and soluble, insoluble solids and carbohydrate concentrations.

M Ali *et al.* (2007) replicated plant growth trials with lettuce using Vermicompost green waste-derived compost and mixtures of two i.e., 50/50 (v/v) of vermicompost and green waste feedstock. They concluded that Vermicomposting process can inhibit plant growth but does not result in an increased availability of nutrients or potentially toxic elements.

Meena *et al.* (2007) made a study on the growth impacts of organic manure on garden pea (*Pisum sativum*) and compared with chemical fertilizer, Vermicast produced higher green pod plants, higher green grain weight per plant, higher percentage of protein, carbohydrates and higher green pod yield (24.8%- 91%)

Sahni *et al.* (2007) carried out experiment in chickpea (*Cicer arietinum*). The collar rot of chickpea is caused by soil borne pathogen *Sclerotium rolfsii* and management of this pathogen is not possible through a single approach. To promote plant growth, the Vermicompost and an antagonistic strain of *Pseudomonas syringae* (PUR46) was applied to the plant. The 25% of Vermicompost along with seed bacterization with PUR46 was the most effective treatment which not only increased the uptake of minerals like P, Mn and Fe in chickpea seedling, but also, they reduced plant mortality.

Clive Edwards *et al.* (2006) carried out studies on application of Vermicompost and Vermiwash (Vermicompost liquid extract) to the disease affected vegetable crops. It was found that Vermicompost could suppress the range of plant disease such as *Pythium* on radishes and *Rhizoctonia* on cucumbers, *Verticillium wilt* on strawberries, *Phomopsis* and powdery mildew on grapes and bacterial rot on cucumber.

Norman Arancon and Clive Edwards (2005) carried out experiment on Vermicompost which increase growth, flowering and yield of vegetable and ornamental crops. Low concentration Vermicompost eg: 2.5 t/ha or 5 t/ha significantly increase the growth and yield of high valuable vegetable and fruit crops. Further application of Vermicompost enhances quality of soil by increasing microbial activity and microbial biomass.

Webster (2005) reported that the usage of Vermicompost increases the yield of cherries for three years on a single application, it also increases soil fertility and viability for longer time.

Nicole D Cavender *et al.* (2003) conducted greenhouse experiment on biological and nutritional effect of Vermicompost on Sorghum bicolor and infection of root by Arbuscular Mycorrhizal Fungi (AMF). Due to application of Vermicompost the substrates N, P and K level increased. In peat medium, the Vermicompost stimulated Mycorrhizal colonization of root. Steam sterilization of Vermicompost had no effect on Mycorrhizal colonization, but also it enhances the dry weight relative to non-sterile treatment.

Jeyabal and Kuppaswamy (2001) have observed that biodigested slurry and weeds are a better combination for Vermicomposting, determining the nutrient content and compost maturity period. Integrated application of Vermicompost, fertilizer viz *Azospirillum* and phosphobacteria increased rice yield by 15.9%. Application of Vermicompost, and Nitrogen fertilizers could be applied to rice legume to achieve higher yields and sustain soil health.

## **CHAPTER 3**

### **MATERIALS AND METHODS**

The plant taken for the current study was *Solanum lycopersicum* L. that belonging to the family *Solanaceae*. Growth studies were carried out under different treatments of organic fertilizers namely Vermicompost and Vermiwash against untreated control at different stages of growth of the plant.

#### **COLLECTION OF SEEDS**

Seeds of *Solanum lycopersicum* L. were obtained from Sundar nursery garden, Chinnamathampalayam, Coimbatore and the same was Authenticated in Botanical Survey of India, TNAU, Coimbatore.

#### **MORPHOLOGY OF PLANT**

*Solanum lycopersicum* L.

#### **SYSTEMATIC POSITION**

Kingdom - Plantae  
Division - Magnoliophyta  
Class - Magnoliopsida  
Order - Solanales  
Family - Solanaceae  
Genus - Solanum  
Species - *S. lycopersicum* L.

#### **DESCRIPTION**

- Tomato, (*Solanum lycopersicum* L.) is an herbaceous plant in the family *Solanaceae* grown for its edible fruit.
- Tomato plants are dicots, and grow as a series of branching stems, with a terminal bud at the tip that does the actual growing. When that tip eventually stops growing, whether

because of pruning or flowering, lateral buds take over and grow into other, fully functional, vines.

- It is a perennial, often grown outdoors in temperate climates as an annual, typically reaching a height of 1–3 m (3 to 10 ft) with a weak, woody stem that often vines over other plants.
- The leaves are 10-25 cm long, pinnate, with 5-9 leaflets, each leaflet upto 8cm long, with a serrated margin; both the stem and leaves are densely glandular-hairy.
- The flowers are 1–2 cm across, yellow, with five pointed lobes on the corolla; they are borne in a cyme of 3–12 together.
- The plant can be erect with short stems or vine- like with long, spreading stems.
- A common tomato fruit contains 10-100 seeds. The seeds will be surrounded by a jelly-like ‘seed coat’ which needs to be removed. The best way to get rid of the seed coat is to soak the seeds in water for 7-10 days. The size of seed varies from 1.75 mm to 3.2 mm. Tomato seed contains 24-25% of oil, but 15-17% oil can be recovered by crushing in expellers. Tomato oil is brown in colour with strong odour. It contains saturated fatty acids up to 14-18%, and unsaturated fatty acids up to 76-80%. For propagation, the seeds need to come from a mature fruit, and be dried or fermented before germination.



**Plate 1** Habit of *Solanum lycopersicum* L.



**Plate 2** Flower of tomato plant

- The stems are covered in coarse hairs and the leaves are arranged spirally.
- The tomato plants produce yellow flowers, which can develop into a cyme of 3-12, and usually a round fruit (berry) which is fleshy, smoothed skinned and can be red, pink, purple, brown, orange or yellow in colour.
- The tomato plant as an annual is harvested after only one growing season.
- Tomato may also be referred to as love apple and originates from south America.

## **ORIGIN AND DISTRIBUTION**

The tomato (*Solanum lycopersicum* L.) is the edible, often red berry -type fruit of the nightshade plant, commonly known as tomato plant. The tomato is consumed in diverse ways, including raw, as an ingredient in many dishes, sauces, salads and drinks.

The tomato belongs to the nightshade family Solnaceae. The species originated in the South American Andens and its use as a food originated in Mexico and spread throughout the World following the Spanish colonization of America. Its many varieties are now widely grown, sometimes in green houses in cooler climates. The plants have a weak stem that often sprawls over the ground and vines over other plants. It is a perennial in its native habitat, although often grown outdoors in temperate climates as an annual. An average common tomato weighs approximately,100 grams (4 oz).



**Plate 3 Plant showing development of Fruit**

## **HEALTH BENEFITS**

Tomatoes offer several health benefits related to their phytonutrient content.

### **Reduce Risk of Prostate Cancer**

Lycopene is an antioxidant in tomatoes that has been associated with a reduced risk of prostate cancer. Lycopene acts on various biochemical pathways that help prevent cancer cells from developing and spreading. Lycopene is higher in processed tomato foods (such as ketchup or canned tomatoes) because the processing involves removing water and leaving a more concentrated tomato product.

### **Supports Heart Health**

The lycopene in tomatoes works synergistically with other antioxidant vitamins (like vitamins A, E, and C) to provide compounding benefits for heart health. Some studies demonstrate a relationship between the lycopene in tomatoes and an oxidized LDL and arterial plaque reduction. Tomatoes also contain potassium, which is well-known to reduce blood pressure.

### **Aids Eyesight**

Tomatoes are an excellent source of vitamin A, and more specifically, lutein and zeaxanthin. These two forms of vitamin A accumulate in the retina and prevent age-related macular degeneration. Consuming tomatoes as a part of dishes that include some fat (such as in a salad with olive oil) improves absorption of the fat-soluble vitamins, which are crucial for good eyesight.

### **Protects Against Sun Damage**

The phytonutrients in tomatoes are protective against some of the effects of UVB damage. Although tomatoes alone aren't enough to prevent skin cancer, including tomatoes in your meal plan may improve your body's resilience to the dangers of certain types of sun rays.

### **May Reduce Risk of Diabetes Complications**

Tomatoes have been associated with antihyperglycemic effects in rodents but not in humans. Nonetheless, tomatoes are still beneficial for people with diabetes. Tomatoes have been shown to

reduce the oxidative stress that's caused by diabetes. They also reduce inflammation, accelerated atherosclerosis, and tissue damage, all common complications of the disease.

## COLLECTION OF VERMICOMPOST AND VERMIWASH

Vermicompost and Vermiwash were collected from Providence College for Women, Spring Field, Bandishola, Coonoor, The Nilgiris. The earthworm species used to produce compost was *Eisenia fetida*. Leaves were collected from local area of Coonoor and dried and mixed with jaggery, cowdung, earthworm (*Eisenia fetida*) and required amount of soil and water to maintain the moisture content.



**Plate 4 Collection of Vermicompost**



**Plate 5 Vermiwash tank**

## METHODS

### EXPERIMENT IN GROW BAGS

The Grow bags (30cm×30cm×45cm size) were collected from Institute of Forest Genetics and Tree Breeding, Coimbatore.

The seeds obtained from Sundar Nursery, Coimbatore were sown in Grow bags containing **red soil** and **Cocopeat** in the ratio **1:1**. The red soil was collected from Forest College and Research Institute, Mettupalayam, Coimbatore, Tamilnadu. The treated bags were maintained in triplicates. The effect of Vermicompost and Vermiwash on the growth parameters of *Solanum lycopersicum* L. were assessed.

The growth parameters at different stages of growth of the plants were analyzed with the comparison of Vermiwash and Vermicompost treatment.

### **MATERIALS REQUIRED**

- Plant – Tomato (*Solanum lycopersicum* L.)
- Number of grow bags – 24
- Tomato seeds
- Vermicompost
- Vermiwash
- Red Soil
- Coir pith

### **VERMIWASH CONCENTRATION**

The Vermiwash at different concentration levels applied to the tomato plants (*Solanum lycopersicum* L.) for analysing the growth parameters were:

<b>NUMBER OF SERIES</b>	<b>CONCENTRATIONS (ml)</b>
T <sub>0</sub>	Control
T <sub>1</sub>	100ml
T <sub>2</sub>	200ml
T <sub>3</sub>	400ml

### **VERMICOMPOST CONCENTRATION**

The Vermicompost at different concentration levels applied to tomato plants (*Solanum lycopersicum* L.) for analysing the growth parameters were:

<b>NUMBER OF SERIES</b>	<b>CONCENTRATION (g)</b>
T <sub>0</sub>	Control
T <sub>1</sub>	100g
T <sub>2</sub>	200g
T <sub>3</sub>	400g

## **GROWTH PARAMETERS**

To measure the growth parameters, plant samples were uprooted carefully on 10<sup>th</sup>, 20<sup>th</sup>, 30<sup>th</sup> and 40<sup>th</sup> days and the following parameters were recorded for all the treatments.

1. Root length (cm)
2. Shoot length (cm)
3. Number of lateral roots
4. Number of leaves
5. Diameter of leaves (cm)

### **Root Length**

The plants were taken from control bag and other treatment bags and washed to get rid of adhering soil particles. Then, the length of the roots was measured with the help of a scale from root collar point to root tip and expressed in centimetre. Three seedlings were randomly selected from each treatment and their root length was measured using cm scale and recorded as cm / seedling.

### **Shoot Length**

To measure the shoot length of the plants, the measurement was taken from the shoot collar point to shoot apex and expressed in centimetre. Three seedlings were randomly selected from each treatment and their root length was measured using cm scale and recorded in cm / seedling. Three readings were taken for statistical analysis.

### **Number of lateral roots**

The number of lateral roots arising from the main primary root was measured.

### **Number of leaves**

The number of leaves present was recorded in the uprooted plants.

### **Diameter of leaves**

The diameter of the leaves was measured for all the treatments along with the control plant and expressed in centimetre.

## **STATISTICAL ANALYSIS**

The data obtained from various morphological observations as well as yield parameters were subjected to statistical analysis as per the procedure of Panse and Sukhatme (1978).

## CHAPTER 4

### RESULTS AND DISCUSSION

The experiment was conducted in tomato plant (*Solanum lycopersicum L.*) using Vermicompost and Vermiwash with control and different concentrations of compost to estimate the growth parameters of tomato plant.

The seedlings were sown in small containers of potting soil and moisture level was maintained (Plate 6 &7). The seeds started germinating in 7 to 14 days. The Germination and initial leaflet formation of the tomato plant is shown in Plate 8 & 9. After 15 to 20 days the transplantation was done to a grow bag with different concentrations of Vermicompost and Vermiwash. Vermiwash also used as foliar spray at intervals.



**Plate 6 & 7 seeds of tomato (*Solanum lycopersicum L.*) sown in grow bag**

The parameters such as shoot length, root length, number of lateral roots, leaves and diameter of leaves were measured on the 10 (Plate 8) and 20 (Plate 9) days after sowing (DAS).



**Plate 8 Germination of seeds and formation of Initial leaflets**

Lateral leaves started forming after 15 days, so the number of leaves formed was also measured on the 30th and 40 (DAS).



**Plate 9 Formation of true Leaflets**

On the 45th day, the root length and shoot length formed was also measured and statistically analysed. The growth parameters as well as the yield parameters were statistically analyzed and the results are tabulated.

Ten days after the seeds were sown, measurement of shoot length, root length, number of lateral roots formed, number of leaves formed, and diameter of the leaves were calculated and tabulated (Table 1). The shoot length was significantly higher in the grow bag in which 100ml (T<sub>1</sub>) and 200ml Vermiwash (T<sub>2</sub>) used. The value obtained was  $5\pm 0.2$ cm and  $5\pm 0.3$ cm respectively. (Fig.1)



**Plate 10 Seedling growth of *Solanum lycopersicum* L. after 10 days**

**TABLE 1**  
**GROWTH PARAMETERS OF *SOLANUM LYCOPERSICUM* L. ON 10<sup>TH</sup> DAY**  
**AFTER SEEDS WERE SOWN**  
**VERMIWASH**

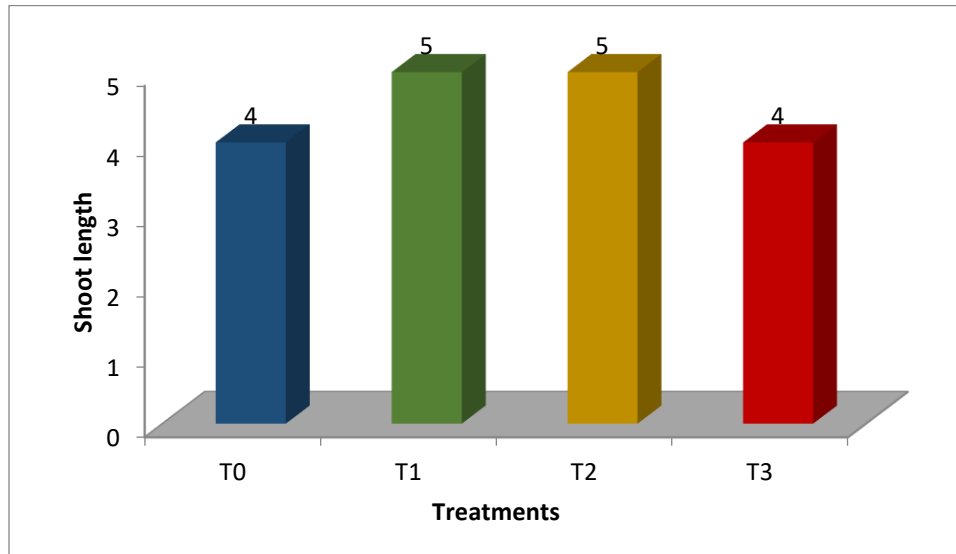
BAGS	SHOOT LENGTH (CM)	ROOT LENGTH (CM)	NO. OF LATERAL ROOTS	NO. OF LEAVES	DIAMETER OF LEAVES (CM)
T <sub>0</sub>	4±0.3	2.5± 0.3	5± 0.3	3± 0.1	0.5± 0.2
T <sub>1</sub>	<b>5± 0.2</b>	4± 0.4	6± 0.2	<b>4± 0.5</b>	<b>1.8± 0.6</b>
T <sub>2</sub>	<b>5±0.3</b>	<b>5± 0.3</b>	<b>8± 0.7</b>	<b>4± 0.3</b>	1.4± 0.3
T <sub>3</sub>	4± 0.8	3± 0.3	7± 0.5	3± 0.4	1± 0.1
SEd	0.5802	0.2677	0.3808	0.2915	0.2887
CD(P<0.04)	1.3380	0.6173	0.8781	0.6723	0.6657

**Plate 11**



**Measurement of Morphological parameters on the 10th day by the application of Vermiwash**

**Figure 1**



**Shoot length**

T<sub>0</sub> - Control

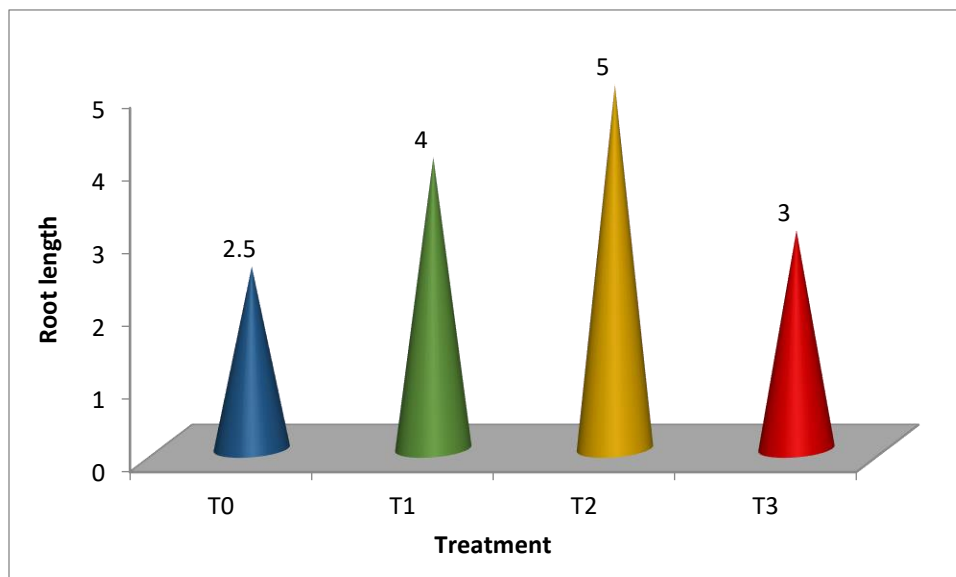
T<sub>1</sub> - 100ml

T<sub>2</sub> - 200ml

T<sub>3</sub> - 400ml

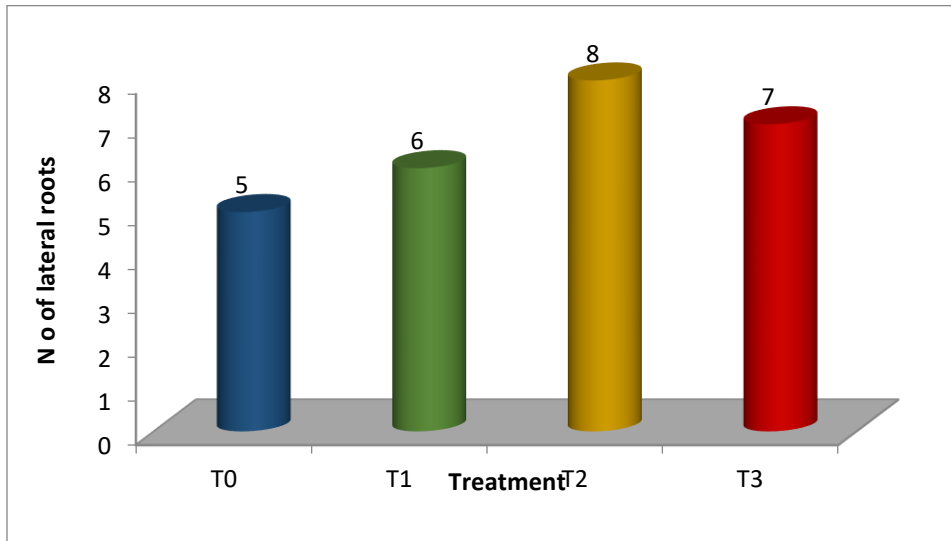
**Figure 2**

**Root length**



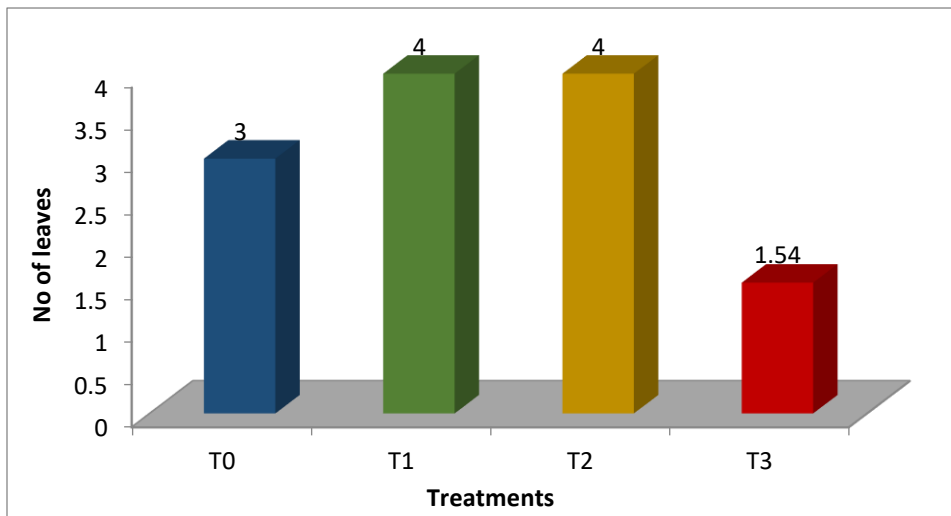
The root length of the *Solanum lycopersicum* L. was found to be higher in plants treated with 200ml (T<sub>2</sub>) Vermiwash (Fig.2) and the reading observed was  $5 \pm 0.3$  cm. The number of lateral roots formed on the 10th day was significantly higher in plants treated with 200ml (T<sub>2</sub>) and value recorded was  $8 \pm 0.7$  (Fig.3). The number of leaves and the diameter of the leaves on the 10th day were higher in T<sub>1</sub> and the readings observed were  $4 \pm 0.5$  (Fig.4) and  $1.8 \pm 0.6$  (Fig.5). T<sub>2</sub> also showed diameter of leaves similar to T<sub>1</sub>.

**Figure 3**



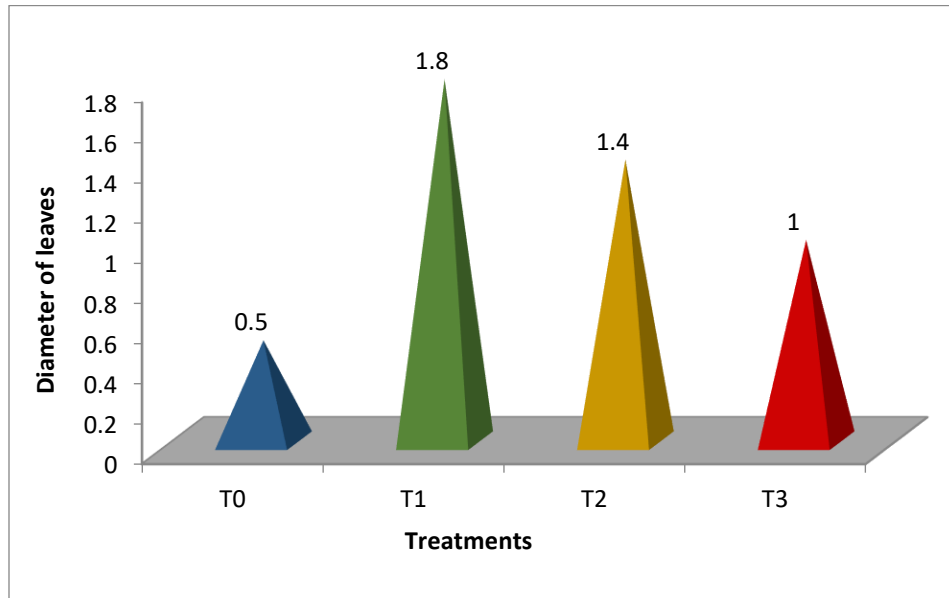
**Number of lateral roots**

**Figure 4**



**Number of leaves**

Figure 5



Diameter of leaves

**GROWTH PARAMETERS OF *Solanum lycopersicum* L. ON 10<sup>th</sup> DAY BY VERMICOMPOST TREATMENT**

The shoot length was significantly higher in the grow bag in which 200g vermicompost (T<sub>2</sub>) was used. The value obtained was 5± 0.25 cm (Fig.6).

TABLE 2

**GROWTH PARAMETERS OF *SOLANUM LYCOPERSICUM* L. ON 10<sup>TH</sup> DAY AFTER SEEDS WERE SOWN**

**VERMICOMPOST**

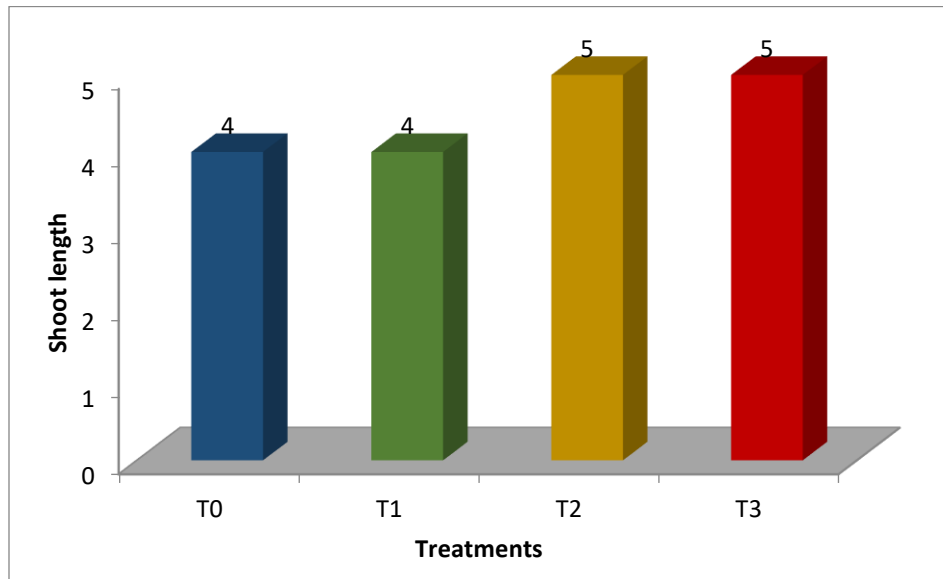
BAGS	SHOOT LENGTH (CM)	ROOT LENGTH (CM)	NO. OF LATERAL ROOTS	NO. OF LEAVES	DIAMETER OF LEAVES (CM)
T <sub>0</sub>	4± 0.4	3± 0.6	5± 0.2	<b>4± 0.4</b>	0.8 ± 0.4
T <sub>1</sub>	4± 0.2	<b>5± 0.8</b>	5± 0.8	3± 0.2	1.2± 0.3
T <sub>2</sub>	<b>5± 0.25</b>	4± 0.4	<b>7± 0.7</b>	<b>4±0.5</b>	<b>1.8± 0.1</b>
T <sub>3</sub>	5± 0.1	4± 0.7	6± 0.9	<b>4± 0.2</b>	1.5± 0.4
SEd	0.2131	0.5244	0.5745	0.2906	0.2646
CD(P<0.04)	0.4914	1.2093	1.3247	0.6701	0.6101

**Plate 12**



**Measurement of morphological parameters on the 10th day by the application of vermicompost**

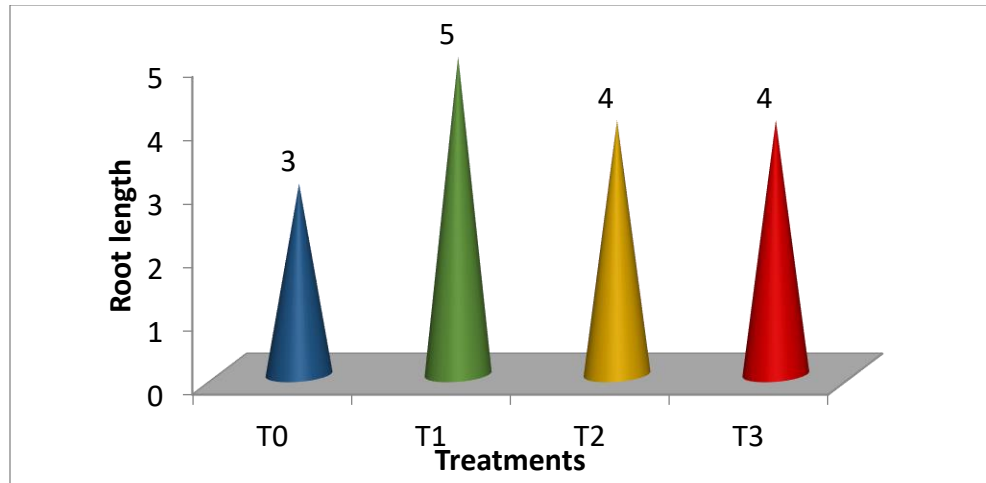
**Figure 6**



**Shoot length**

- T<sub>0</sub> - Control
- T<sub>1</sub> - 100g
- T<sub>2</sub> - 200g
- T<sub>3</sub> - 400g

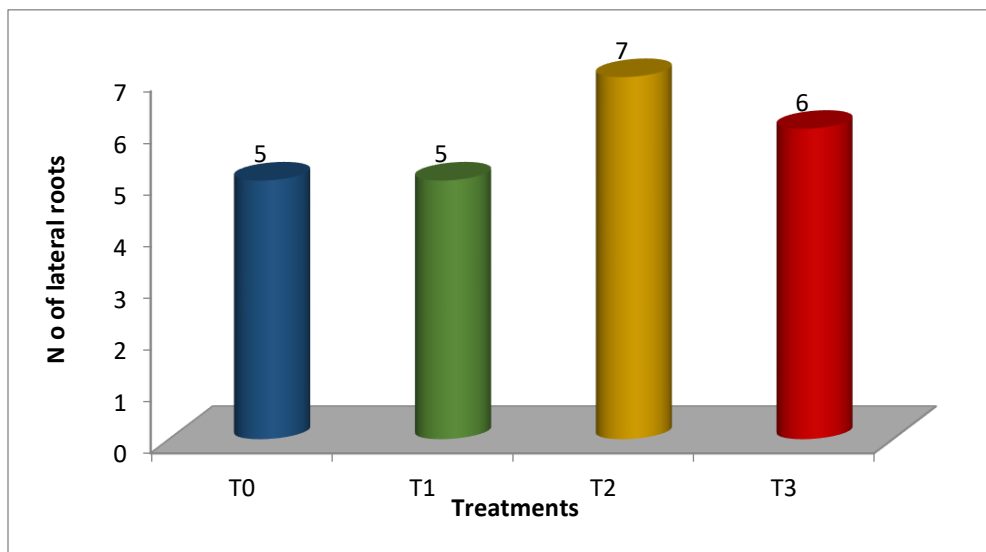
**Figure 7**



**Root length**

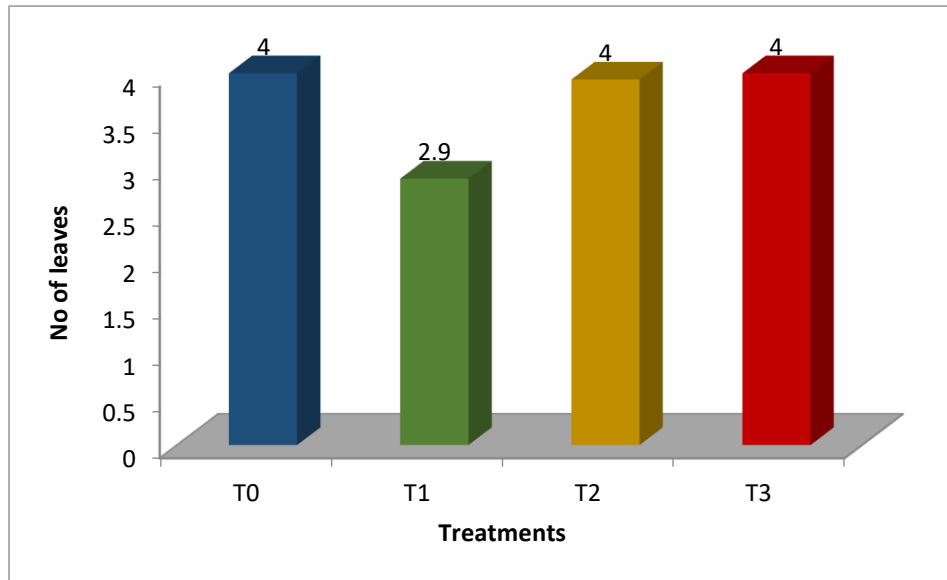
The root length of the *Solanum lycopersicum* L. was found to be higher in plants treated with 100g (T<sub>1</sub>) Vermicompost (Fig.7) and the reading observed was  $5 \pm 0.8$ cm. The number of lateral roots formed on the 10th day was significantly higher in plants treated with 200g (T<sub>2</sub>) and value recorded was  $7 \pm 0.7$  (Fig.8). The number of leaves was found to be almost equal in control plants and T<sub>2</sub> and T<sub>3</sub>. The measurement observed were  $4 \pm 0.4$ ,  $4 \pm 0.5$ , (Fig.9) and  $4 \pm 0.2$  respectively. The diameter of leaves was found to be higher in (T<sub>2</sub>)  $1.8 \pm 0.1$ cm (fig.10)

**Figure 8**



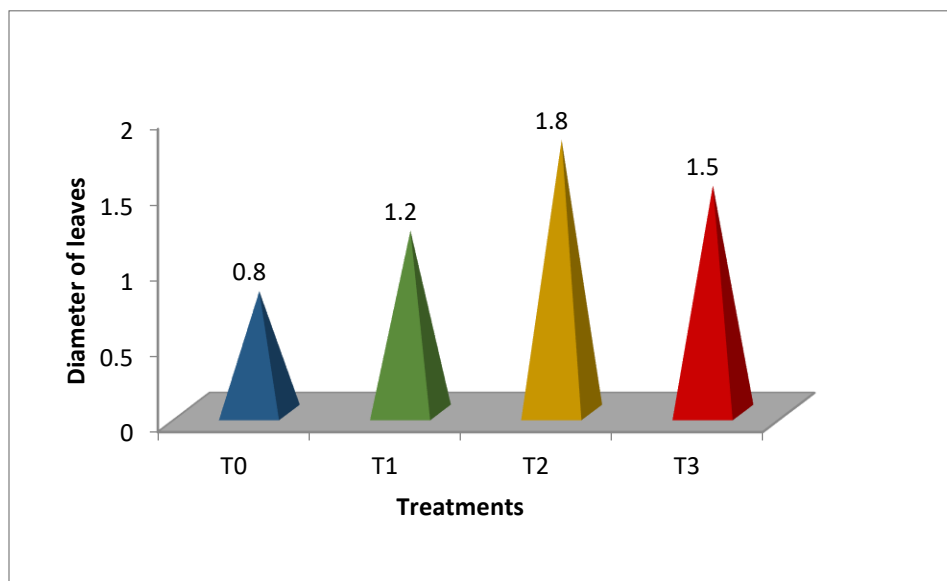
**Number of lateral roots**

**Figure 9**



**Number of leaves**

**Figure 10**



**Diameter of leaves**

**GROWTH PARAMETERS OF *Solanum lycopersicum* L. ON 20<sup>th</sup> DAY IN VERMIWASH TREATMENT**

On the 20<sup>th</sup> day (Table 3), the shoot length was found to be significantly higher in T<sub>1</sub> i.e., the tomato plant was grown using 100ml of Vermiwash. The reading was observed to be 10± 0.9 cm (Fig.11). The root length on the 20<sup>th</sup> day was higher in control plant (7± 0.8cm; Fig.12).

**TABLE 3**

**GROWTH PARAMETERS OF *SOLANUM LYCOPERSICUM* L. ON 20<sup>TH</sup> DAY  
VERMIWASH**

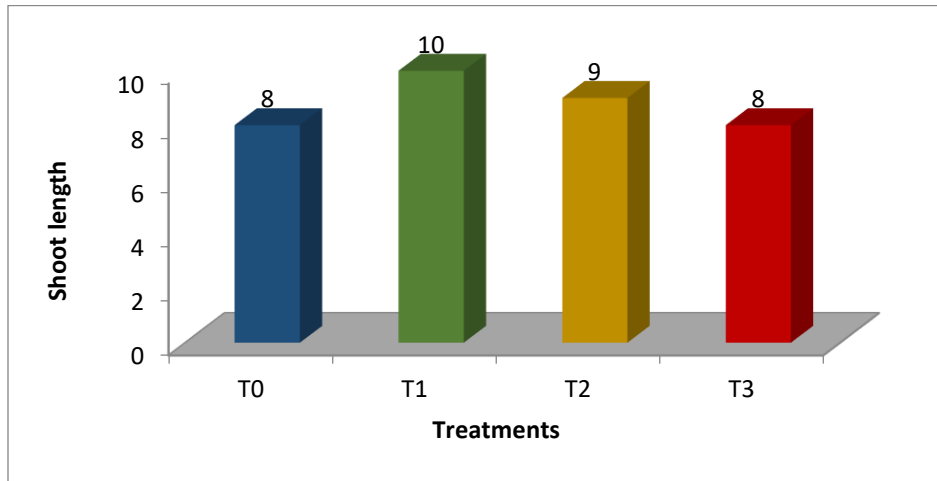
BAGS	SHOOT LENGTH (CM)	ROOT LENGTH (CM)	NO. OF LATERAL ROOTS	NO. OF LEAVES	DIAMETER OF LEAVES (CM)
T <sub>0</sub>	8± 0.5	<b>7± 0.8</b>	18± 0.8	6± 0.7	3± 0.3
T <sub>1</sub>	<b>10± 0.9</b>	6± 0.3	<b>19± 1.3</b>	8± 0.1	<b>5± 0.9</b>
T <sub>2</sub>	9± 0.7	6± 0.6	18±1.1	<b>10± 0.8</b>	3± 0.8
T <sub>3</sub>	8± 0.6	5± 0.2	16± 0.8	9± 0.4	<b>5± 0.4</b>
SEd	0.5642	0.4340	0.8347	0.4655	0.5323
CD(P<0.04)	1.3011	1.0008	1.9248	1.0734	1.2275

**Plate 13**



**Growth of *Solanum lycopersicum* L. on 20<sup>th</sup> day after transplant**

**Figure 11**



**Shoot length**

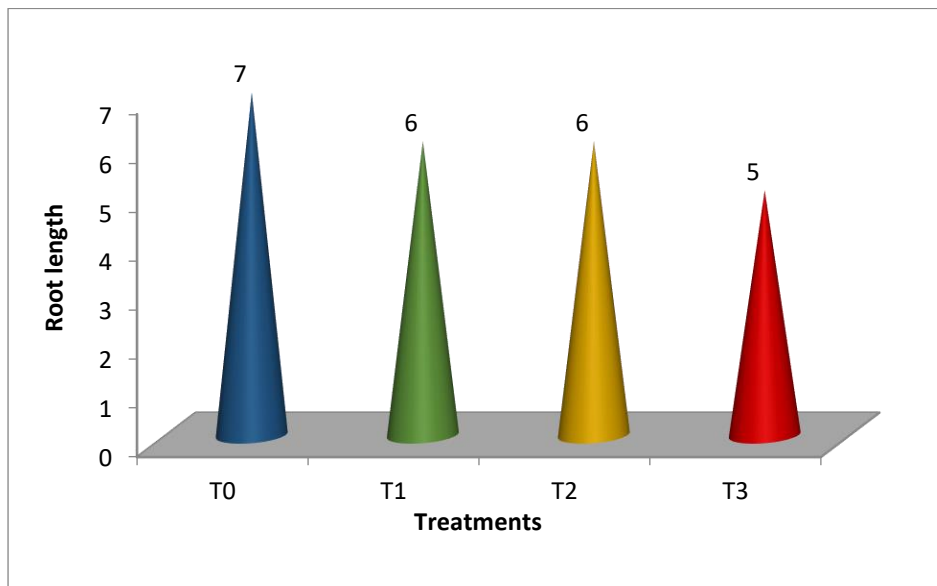
T<sub>0</sub> - Control

T<sub>1</sub> - 100ml

T<sub>2</sub> - 200ml

T<sub>3</sub> - 400ml

**Figure 12**



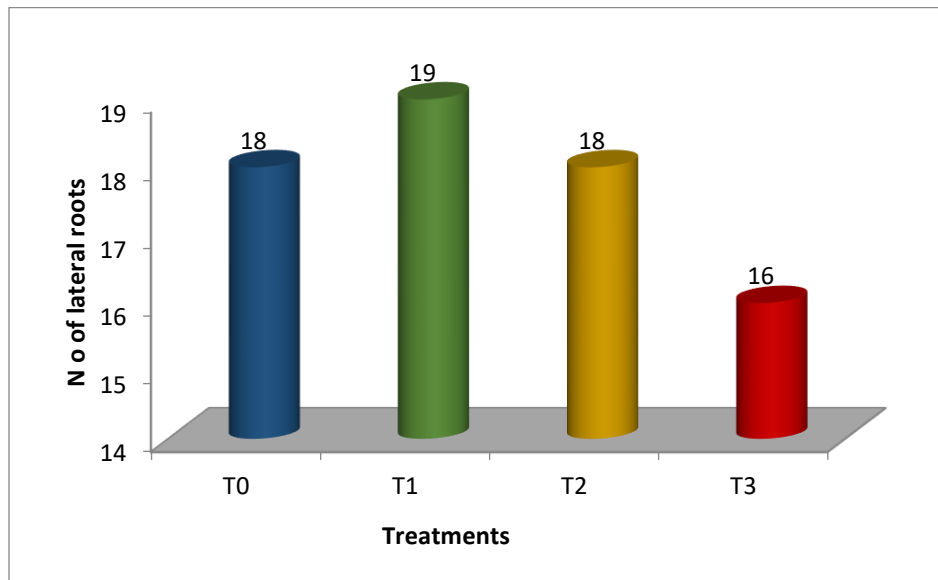
**Root length**

**Plate 14**



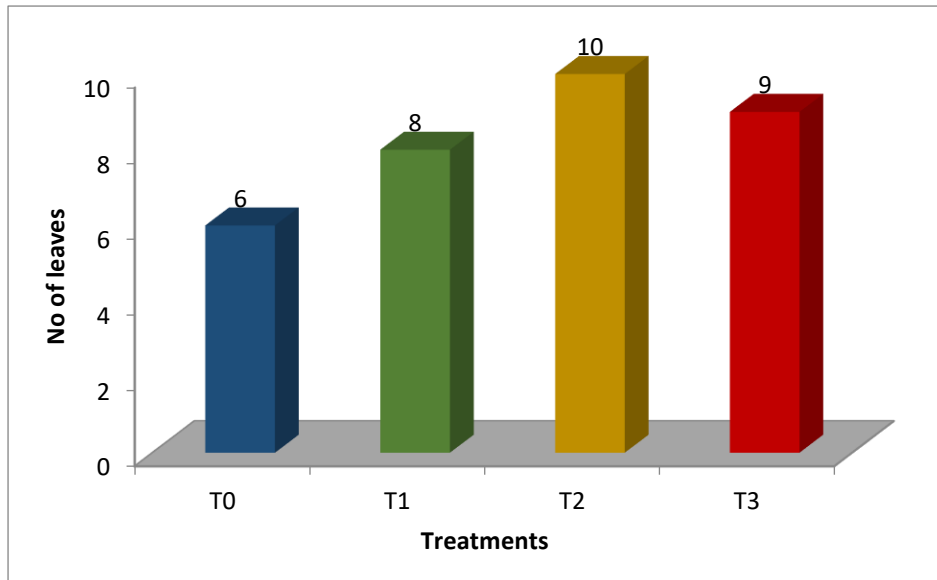
**Measurement of morphological parameters on the 20<sup>th</sup> day by the application of Vermiwash**

**Figure 13**



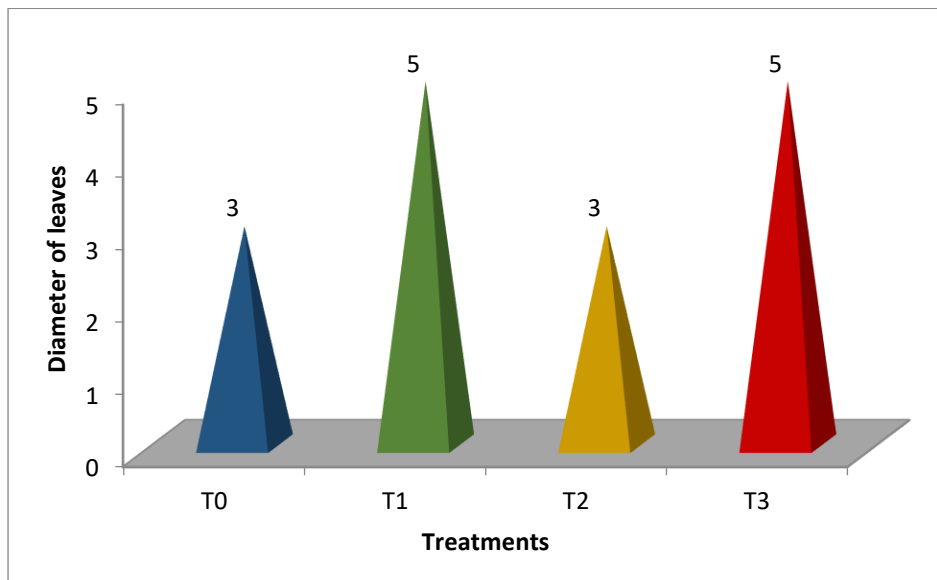
**Number of lateral roots**

**Figure 14**



**Number of leaves**

**Figure 15**



**Diameter of leaves**

The number of lateral roots was found to be maximum in plants treated with 100ml of Vermiwash (T<sub>1</sub>) on the 20<sup>th</sup> day and the value was 19± 1.3cm (Fig13.). Significantly higher number of leaves (Fig.14) and diameter of leaves (Fig.15) were observed in T<sub>2</sub> and T<sub>1</sub> on the 20<sup>th</sup> day and the values were found to be 10± 0.8 and 5± 0.9 cm respectively.

**GROWTH PARAMETERS OF *Solanum lycopersicum* L. ON 20<sup>th</sup> DAY IN VERMICOMPOST TREATMENT**

On the 20<sup>th</sup> day (Table 4), the shoot length was found to be significantly higher in T<sub>1</sub> i.e., the tomato plant treated with 100ml of Vermiwash. The reading was observed to be 10± 0.5 cm (Fig.16). The root length on the 20<sup>th</sup> day was higher in T<sub>2</sub>(7± 0.5cm; Fig.17).

**TABLE 4**

**GROWTH PARAMETERS OF *SOLANUM LYCOPERSICUM* L.ON 20<sup>TH</sup> DAY  
VERMICOMPOST**

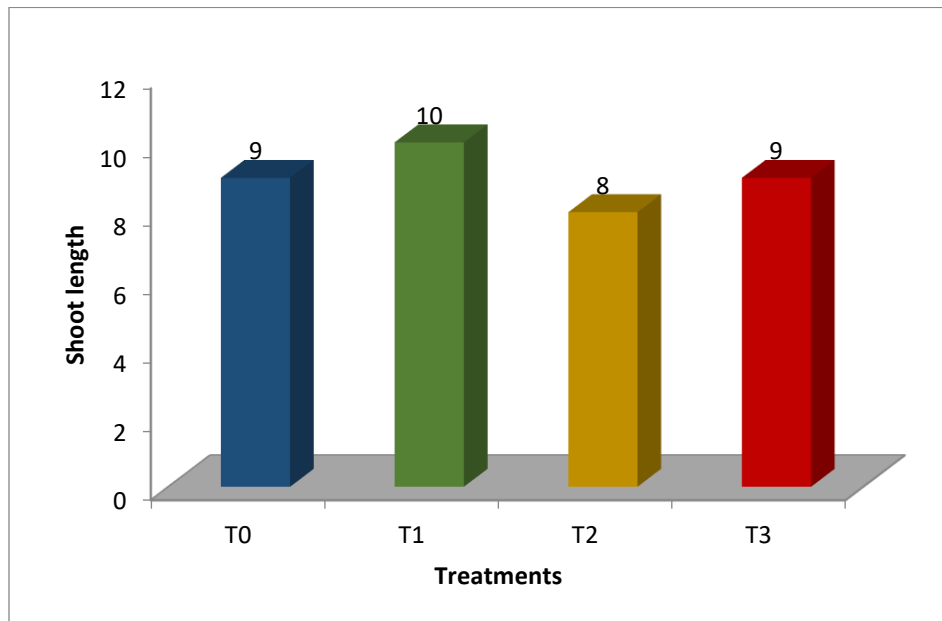
<b>BAG</b>	<b>SHOOT LENGTH (CM)</b>	<b>ROOT LENGTH (CM)</b>	<b>NO. OF LATERAL ROOTS</b>	<b>NO. OF LEAVES</b>	<b>DIAMETER OF LEAVES (CM)</b>
T <sub>0</sub>	9± 0.5	6± 0.2	<b>19± 1</b>	8± 0.7	4± 0.1
T <sub>1</sub>	<b>10± 0.5</b>	6± 0.5	18± 1.1	6± 0.8	4± 0.5
T <sub>2</sub>	8± 0.4	<b>7± 0.5</b>	18± 1.1	9± 0.3	<b>5± 0.8</b>
T <sub>3</sub>	9± 0.6	6± 0.1	17± 0.9	<b>10± 0.1</b>	3± 0.4
SEd	0.4125	0.3037	0.8641	0.4528	0.4203
CD(P<0.04)	0.9512	0.7003	1.9926	1.0441	0.9693

Plate 15



Growth of *Solanum lycopersicum* L. after 20<sup>th</sup> day in control and treatments

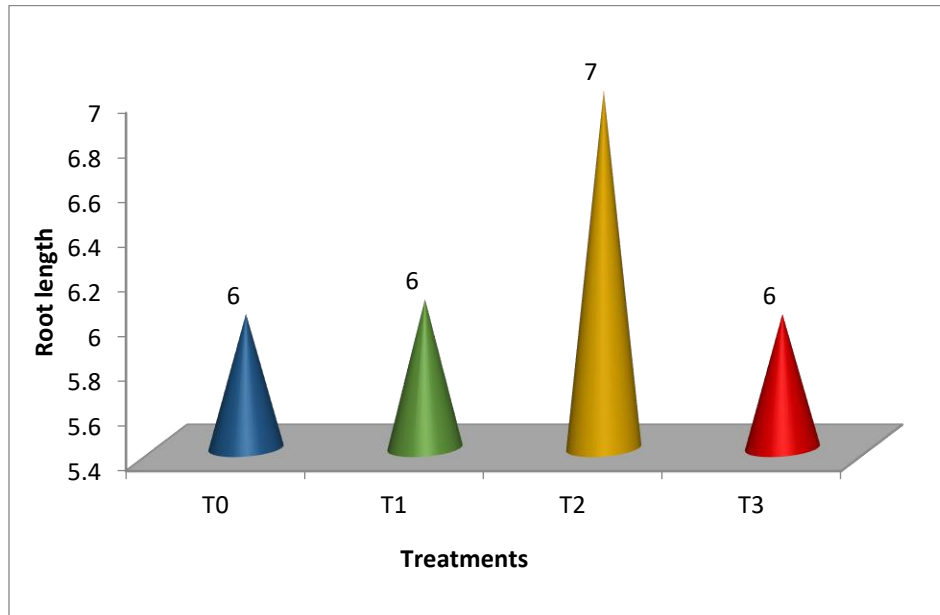
Figure 16



Shoot length

- T<sub>0</sub> - Control
- T<sub>1</sub> - 100g
- T<sub>2</sub> - 200g
- T<sub>3</sub> - 400g

**Figure 17**



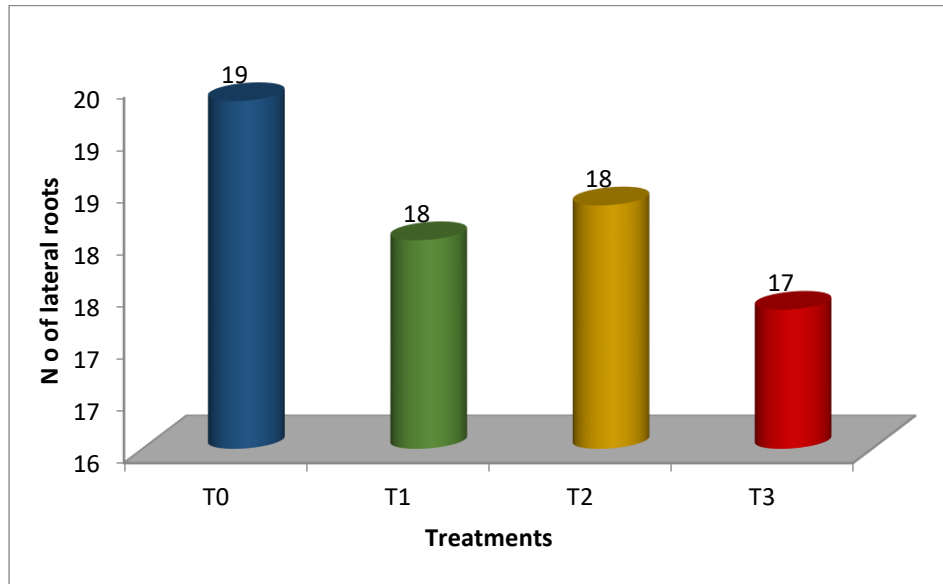
**Root length**

**Plate 16**



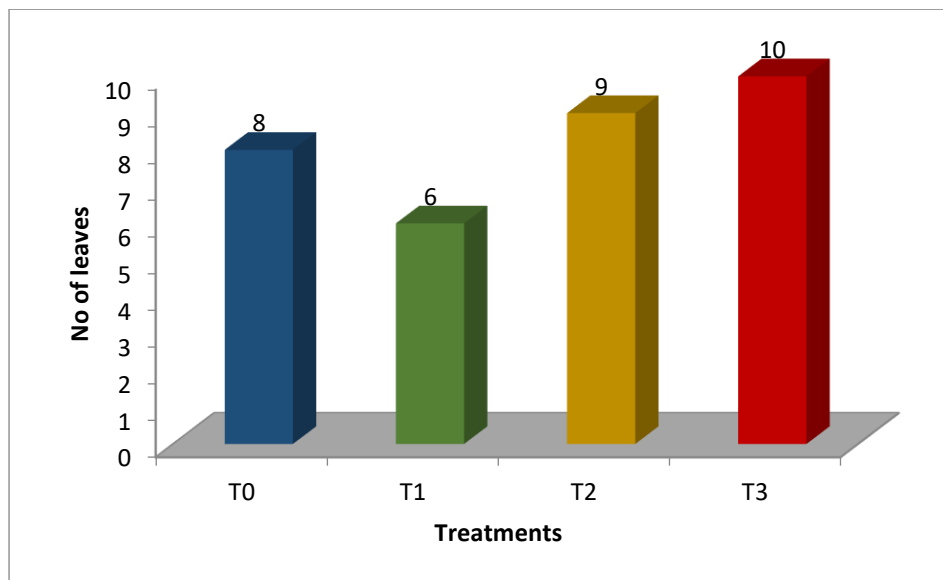
**Measurement of morphological parameters on the 20<sup>th</sup> day by the application of Vermicompost**

**Figure 18**



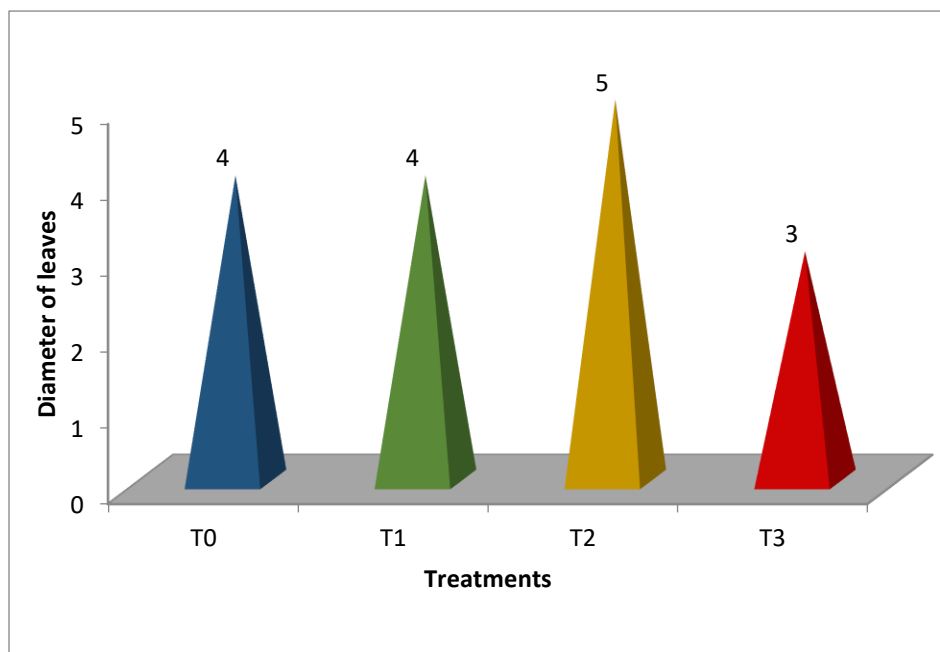
**Number of lateral roots**

**Figure 19**



**Number of leaves**

**Figure 20**



**Diameter of leaves**

The number of lateral roots was found to be maximum in plants grown under control (T<sub>0</sub>) on the 20<sup>th</sup> day and the value was 19± 1cm (Fig.18.). Significantly higher number of leaves (Fig.19) and diameter of leaves (Fig.20) were observed in T<sub>3</sub> and T<sub>2</sub> and the 20<sup>th</sup> day and the values were found to be 10± 0.1 and 5± 0.8cm respectively.

### **GROWTH PARAMETERS OF *Solanum lycopersicum* L. ON 30<sup>th</sup> DAY IN VERMIWASH TREATMENT**

On the 30<sup>th</sup> day (Table 5; Plate 16 & 17), the shoot length and root length was found to be significantly higher in T<sub>2</sub> and T<sub>3</sub> and the values were 18± 1.2cm and 11± 0.3cm respectively (Fig.21 & 22).

**Plate 17**



**Growth of *Solanum lycopersicum* L. after 30<sup>th</sup> day in control and treatments**

The number of lateral roots formed on the 30<sup>th</sup> day was comparatively higher in T<sub>2</sub> than the control plant. The observed value was  $31 \pm 1.5$  (Fig.23). The number of leaves was found to be higher in T<sub>2</sub> on the 30<sup>th</sup> day. The value recorded was  $16 \pm 0.8$  (Fig.24).

**Plate 18**



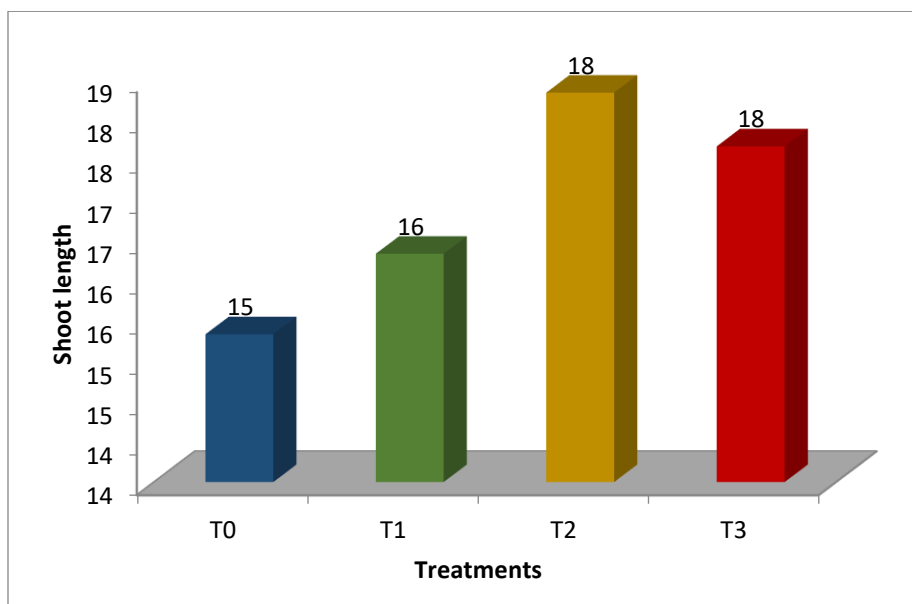
**Measurement of morphological parameters on the 30<sup>th</sup> day by the application of Vermiwash**

The diameter of the leaves was found to be significantly higher in plants treated with 200ml of Vermiwash as well as 400ml. The values for the same were  $6 \pm 0.3$  cm and  $6 \pm 0.4$  cm (Fig.25) respectively.

**TABLE 5**  
**GROWTH PARAMETERS OF *SOLANUM LYCOPERSICUM* ON 30<sup>TH</sup> DAY**  
**VERMIWASH**

BAGS	SHOOT LENGTH (CM)	ROOT LENGTH (CM)	NO. OF LATERAL ROOTS	NO. OF LEAVES	DIAMETER OF LEAVES (CM)
T <sub>0</sub>	15± 0.9	7± 0.7	28± 1.1	14± 1.2	5± 0.8
T <sub>1</sub>	16± 1.3	9± 0.8	29± 1.6	15± 0.8	5± 0.9
T <sub>2</sub>	<b>18± 1.2</b>	10± 0.9	<b>31± 1.5</b>	<b>16± 0.8</b>	<b>6± 0.3</b>
T <sub>3</sub>	17± 1.2	<b>11± 0.3</b>	30± 1.3	15± 0.9	<b>6± 0.4</b>
SEd	1.8469	0.5401	1.1518	0.9775	0.4453
CD(P<0.04)	4.2591	1.2454	2.6561	2.2542	1.0270

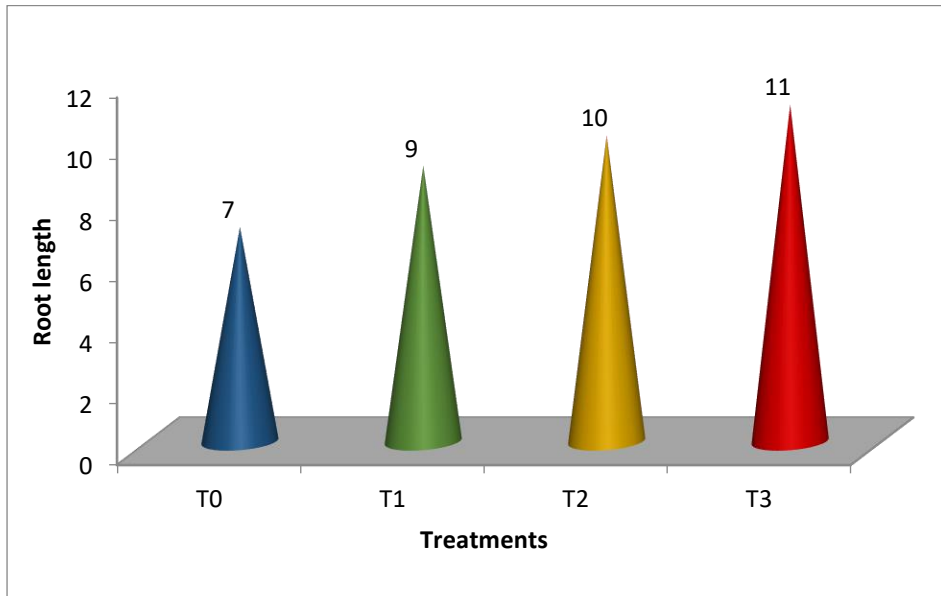
**Figure 21**



**Shoot length**

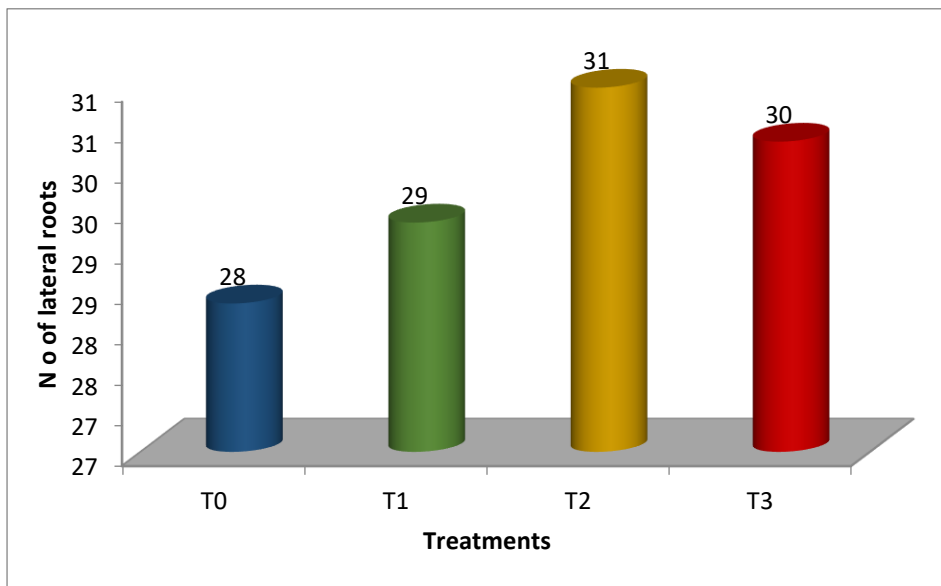
T<sub>0</sub> - Control    T<sub>1</sub> - 100ml    T<sub>2</sub> - 200ml    T<sub>3</sub> - 400ml

**Figure 22**



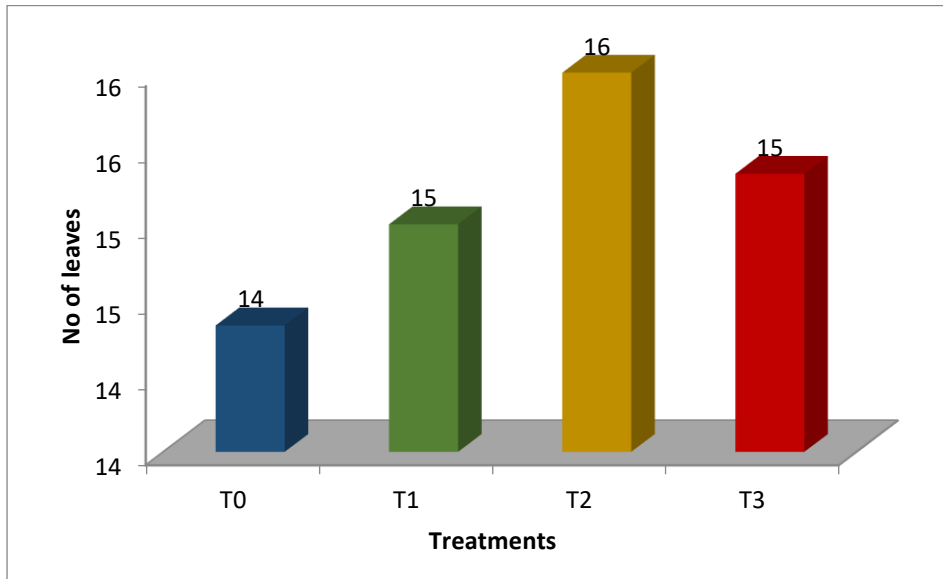
**Root length**

**Figure 23**



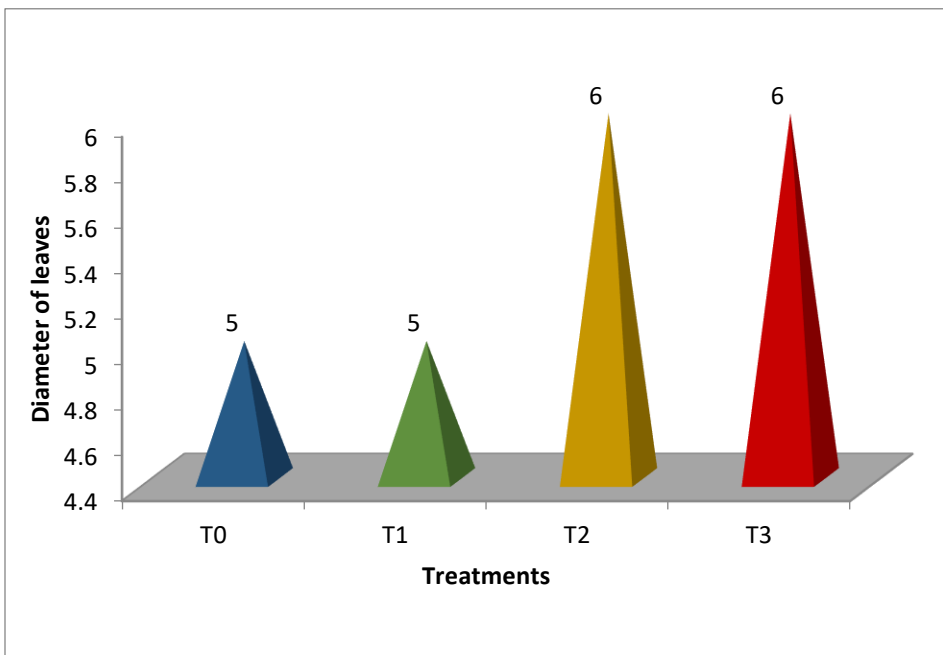
**Number of lateral roots**

**Figure 24**



**Number of leaves**

**Figure 25**



**Diameter of leaves**

## GROWTH PARAMETERS OF *Solanum lycopersicum* L. ON 30<sup>th</sup> DAY IN VERMICOMPOST TREATMENT

On the 30th day (Table 6; Plate 18) the shoot length was found to be significantly higher in both T<sub>1</sub> and T<sub>3</sub> and the values was  $18 \pm 1.3$ cm and the root length was found to be higher in T<sub>3</sub> ( $10 \pm 0.3$ ) i.e. the plant supplemented with different concentrations of Vermiwash (Fig.26 & 27).

Plate 19



Growth of *Solanum lycopersicum* L. after 30<sup>th</sup> day in control and treatment

Plate 20



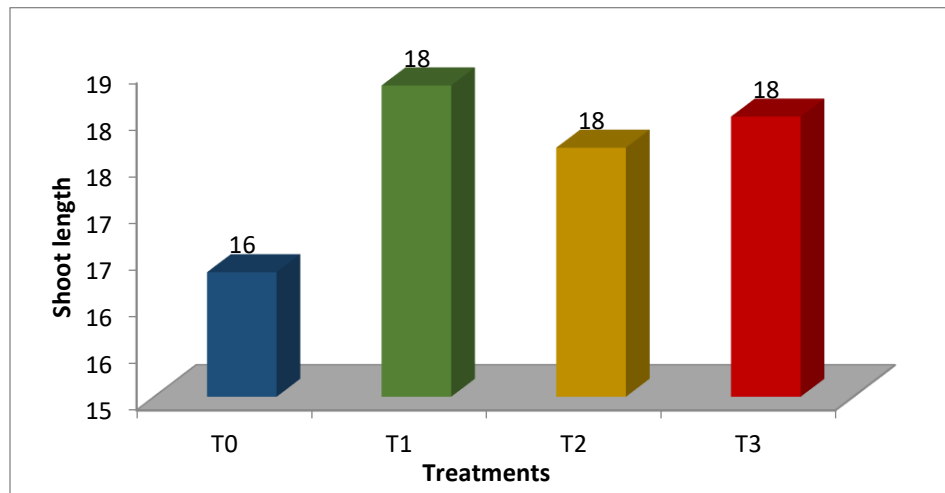
Measurement of morphological parameters on the 30<sup>th</sup> day by the application of Vermicompost

The diameter of the leaves found to be significantly higher in plants treated with 400g of Vermicompost(T3). The value is  $7 \pm 0.3\text{cm}$  (Fig.28) respectively. The number of lateral roots formed was found to be more in T<sub>2</sub> and the observed value was  $31 \pm 1.6$  (fig. 28). The number of leaves was almost similar in control plant and T<sub>3</sub> plants and the value recorded were  $16 \pm 1.3$  and  $16 \pm 1.1$  respectively (fig.29)

**TABLE 6**  
**GROWTH PARAMETERS OF *SOLANUM LYCOPERSICUM* ON 30<sup>TH</sup> DAY**  
**VERMICOMPOST**

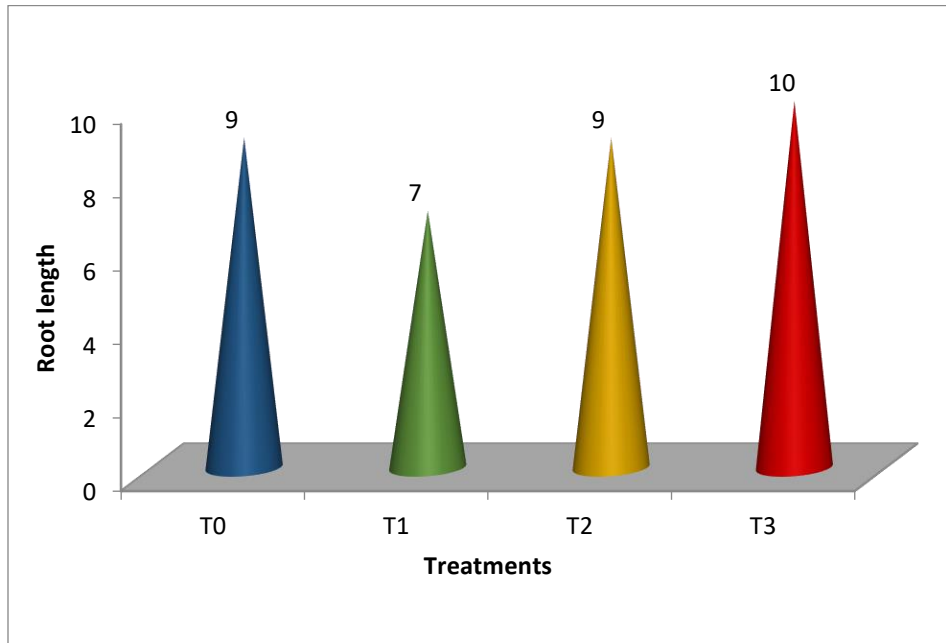
BAGS	SHOOT LENGTH (CM)	ROOT LENGTH (CM)	NO. OF LATERAL ROOTS	NO. OF LEAVES	DIAMETER OF LEAVES (CM)
T0	$16 \pm 1.0$	$9 \pm 0.7$	$29 \pm 1.6$	$16 \pm 1.3$	$6 \pm 0.9$
T1	$18 \pm 1.3$	$7 \pm 0.6$	$28 \pm 1.6$	$15 \pm 1.2$	$5 \pm 0.5$
T2	$17 \pm 1.2$	$9 \pm 0.9$	$31 \pm 1.6$	$14 \pm 1.2$	$6 \pm 0.2$
T3	$18 \pm 1.3$	$10 \pm 0.3$	$30 \pm 1.1$	$16 \pm 1.1$	$7 \pm 0.3$
SEd	1.7868	0.5401	1.2273	2.1107	0.4453    1.0270
CD(P<0.04)	4.1205	1.2454	2.8301	4.8673	

**Figure 26**



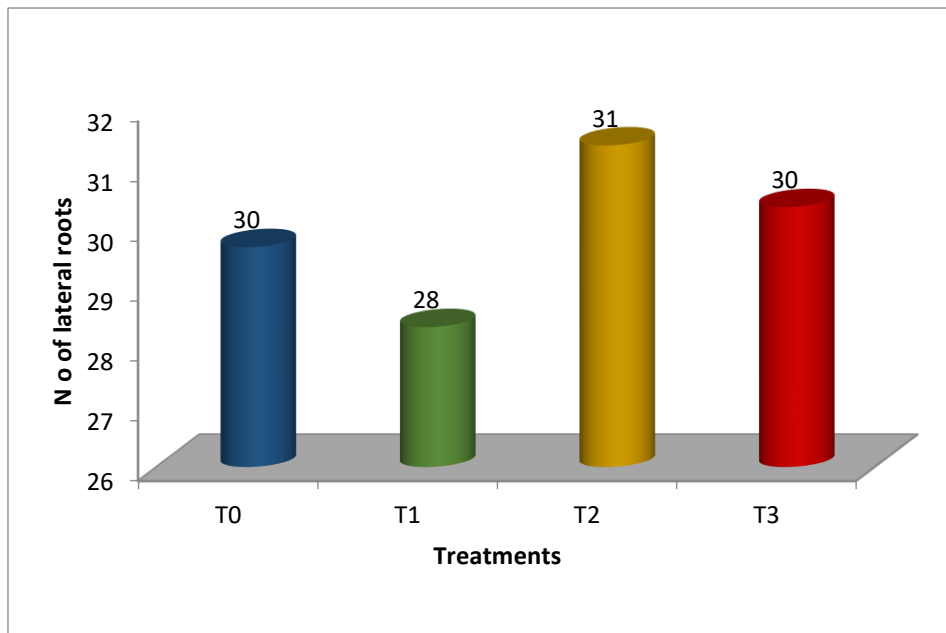
T<sub>0</sub> - Control    T<sub>1</sub> - 100g    T<sub>2</sub> - 200g    T<sub>3</sub> - 400g

**Figure 27**



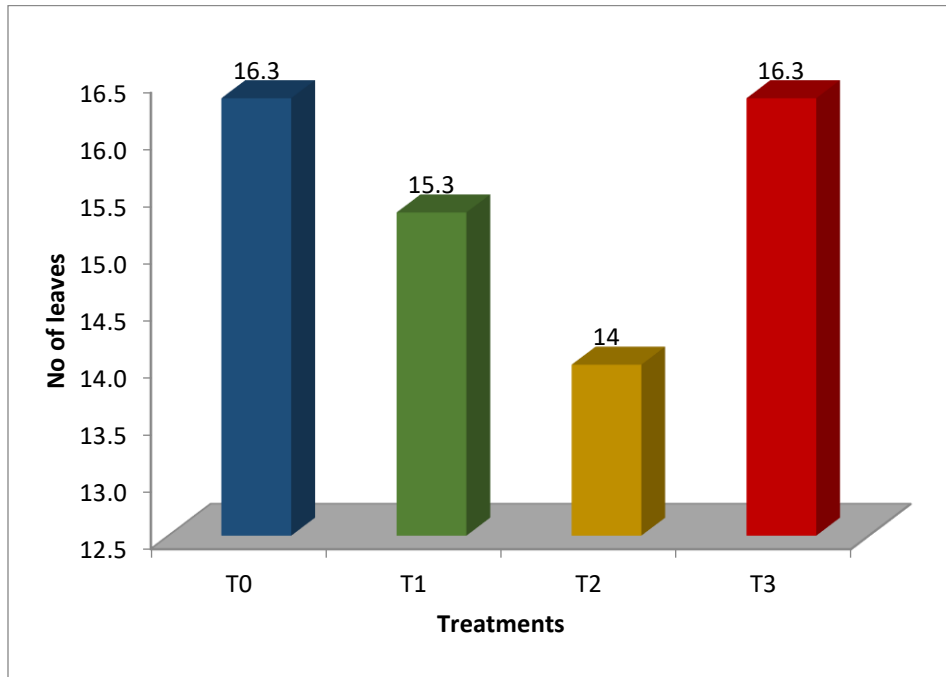
**Root length**

**Figure 28**



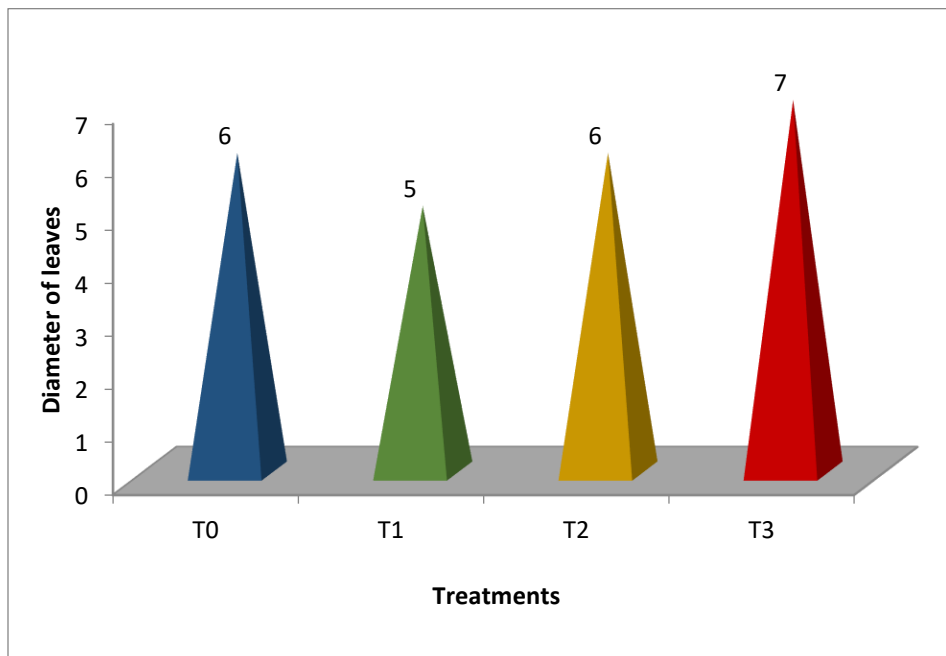
**Number of lateral roots**

**Figure 29**



**Number of leaves**

**Figure 30**



**Diameter of leaves**

**GROWTH PARAMETERS OF *Solanum lycopersicum* L. ON 40<sup>th</sup> DAY IN VERMIWASH TREATMENT**

On the 40<sup>th</sup> day (Table 7), the shoot length was found to be significantly higher in T<sub>2</sub> i.e., the tomato plant was grown using 200ml of Vermiwash. The reading was observed to be 21± 1.6cm (Fig.31). The root length on the 40<sup>th</sup> day was higher in T<sub>1</sub> (13± 0.6cm; Fig.32).

**TABLE 7**

**GROWTH PARAMETERS OF *SOLANUM LYCOPERSICUM* ON 40<sup>TH</sup> DAY  
VERMIWASH**

<b>BAGS</b>	<b>SHOOT LENGTH (CM)</b>	<b>ROOT LENGTH (CM)</b>	<b>NO. OF LATERAL ROOTS</b>	<b>NO. OF LEAVES</b>	<b>DIAMETER OF LEAVES (CM)</b>
T0	20± 1.5	12± 0.4	35± 1.9	<b>21± 1.4</b>	8± 0.8
T1	19± 1.6	<b>13± 0.6</b>	38± 1.7	20± 1.3	8± 0.4
T2	<b>21± 1.6</b>	11± 0.8	<b>39± 1.6</b>	20± 1.1	<b>9± 0.9</b>
T3	19± 1.7	11± 0.1	34± 1.6	19± 1.4	7±0.2
SEd	.7237	0.4416	3.6774	2.7839	0.5244
CD(P<0.04)	3.9749	1.0183	8.4802	6.4197	1.2093

T<sub>0</sub> - Control

T<sub>1</sub> - 100ml

T<sub>2</sub> - 200ml

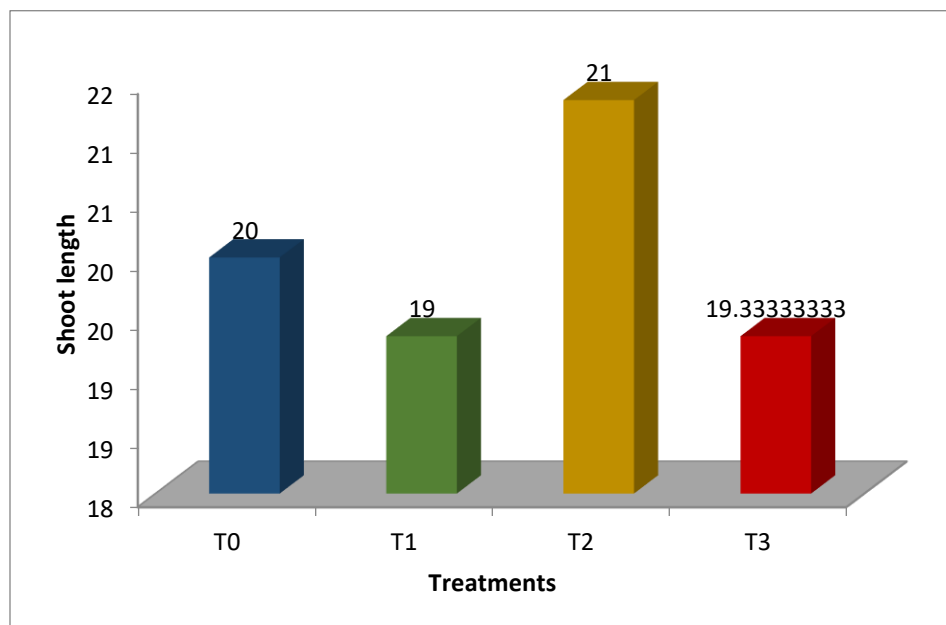
T<sub>3</sub> - 400ml

Plate 21



Growth of *Solanum lycopersicum* L. after 40<sup>th</sup> day in control and treatments

Figure 31



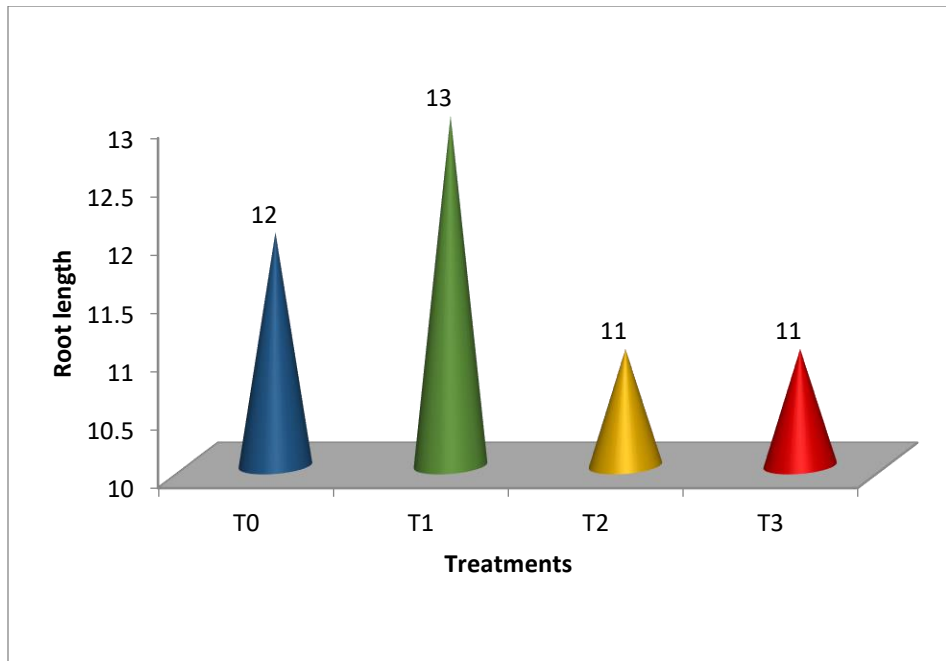
Shoot length

Plate 22



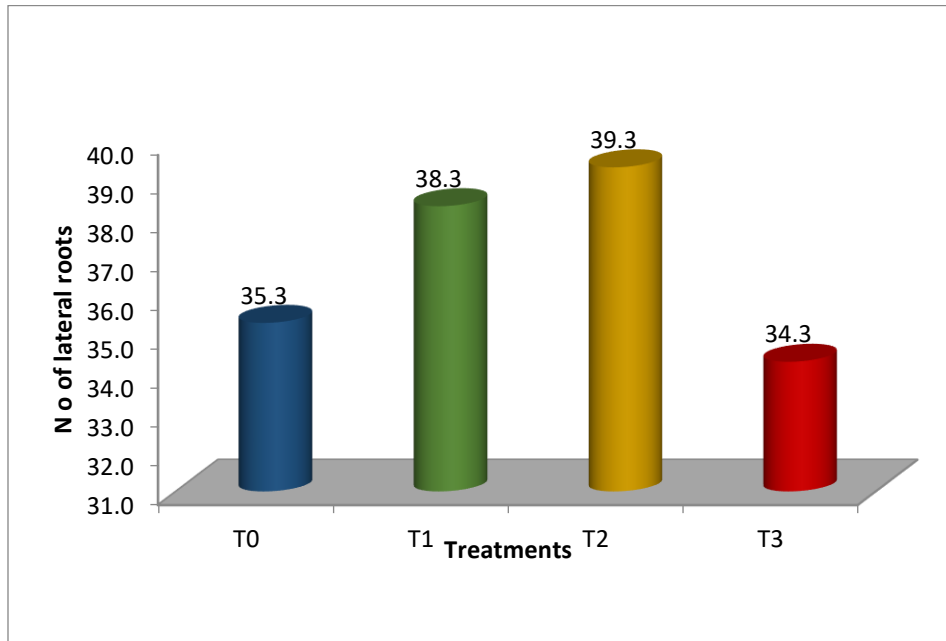
Measurement of morphological parameters on the 40<sup>th</sup> day by the application of Vermiwash

Figure 32



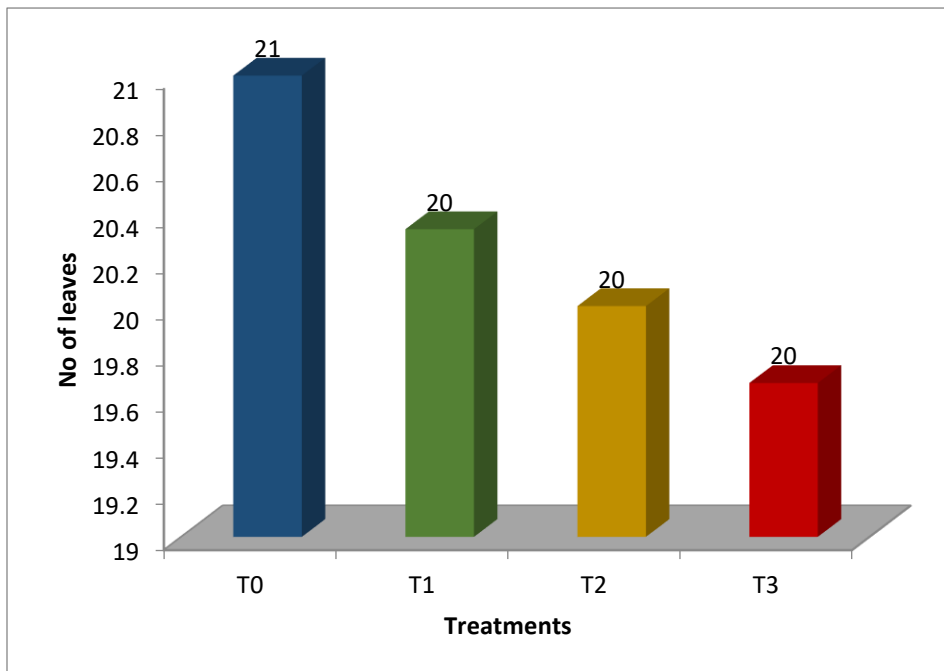
Root length

**Figure 33**



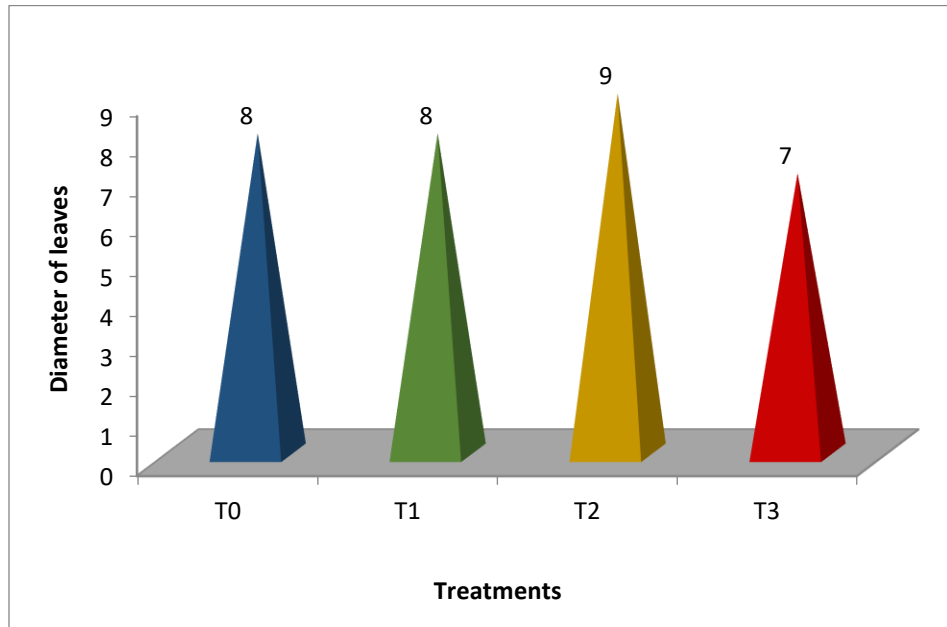
**Number of lateral roots**

**Figure 34**



**Number of leaves**

**Figure 35**



**Diameter of leaves**

The number of lateral roots was found to be maximum in plants treated with 200ml Vermiwash (T<sub>2</sub>) on the 40<sup>th</sup> day and the value was  $39 \pm 1.6$ cm (Fig.33.). Significantly higher number of leaves (Fig.34) and diameter of leaves (Fig.35) were observed in T<sub>0</sub> and T<sub>2</sub> on the 40<sup>th</sup> day and the values were found to be  $21 \pm 1.4$  and  $9 \pm 0.9$ cm respectively.

**Plate 23**



**Flowering of plant after 40 days**

**Plate 24**



**fruit formation of plant**

Plate 23 shows buds and flowers from the plants that can be utilized for further growth. The flowers are observed 40<sup>th</sup> DAS. The first flower bud was seen in (T<sub>1</sub>) i.e., 100ml of Vermiwash concentration. Fruit was also seen after 55days of growth. (Plate 24)

### **GROWTH PARAMETERS OF *Solanum lycopersicum* L. ON 40<sup>th</sup> DAY IN VERMICOMPOST TREATMENT**

On the 40<sup>th</sup> day (Table 8), the shoot length was found to be significantly higher in T<sub>1</sub> i.e., the tomato plant was grown using 100g of Vermicompost. The reading was observed to be 22± 1.5cm (Fig.36). The root length on the 40<sup>th</sup> day was higher in T<sub>2</sub> (14± 1.3cm; Fig.37).

**Plate 25**



**Measurement of morphological parameters on the 40<sup>th</sup> day by the application of Vermicompost**

**TABLE 8**  
**GROWTH PARAMETERS OF *SOLANUM LYCOPERSICUM* L. ON 40<sup>TH</sup> DAY**  
**VERMICOMPOST**

<b>BAGS</b>	<b>SHOOT LENGTH (CM)</b>	<b>ROOT LENGTH (CM)</b>	<b>NO. OF LATERAL ROOTS</b>	<b>NO. OF LEAVES</b>	<b>DIAMETER OF LEAVES</b>
T <sub>0</sub>	20± 1.4	13± 1.7	36± 1.6	<b>22± 1.6</b>	7± 0.7
T <sub>1</sub>	<b>22± 1.5</b>	12± 1.2	38± 1.7	21± 1.7	<b>9± 0.1</b>
T <sub>2</sub>	20± 1.8	<b>14± 1.3</b>	<b>40± 1.2</b>	21± 0.7	<b>9± 0.6</b>
T <sub>3</sub>	19± 1.1	13± 1.6	35± 1.4	19± 1.4	7± 0.7
SEd	1.2014	1.1958	3.5958	1.1609	.2358
CD(P<0.04)	2.7704	2.7576	8.2921	2.6770	2.8498

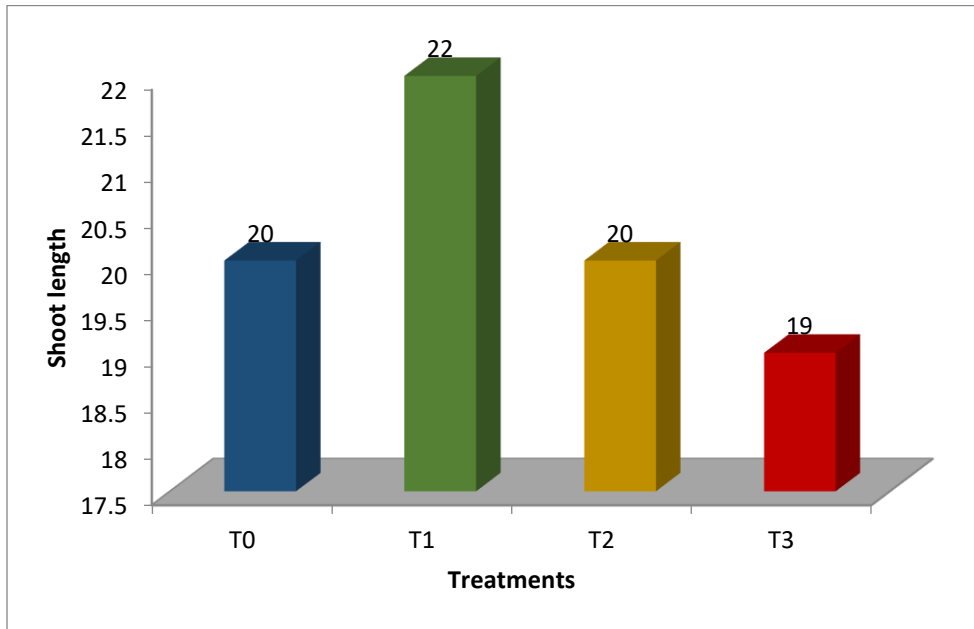
**Plate 26**



**Growth of *Solanum lycopersicum* L. after 40<sup>th</sup> day in control and treatments by the application of vermicompost**

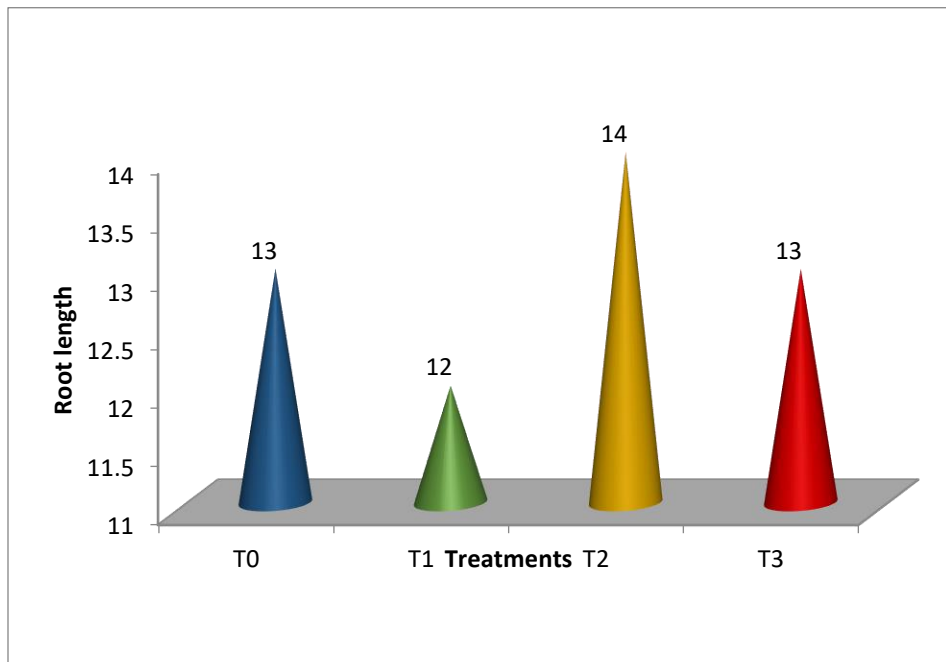
T<sub>0</sub> - Control      T<sub>1</sub> - 100g      T<sub>2</sub> - 200g      T<sub>3</sub> - 400g

**Figure 36**



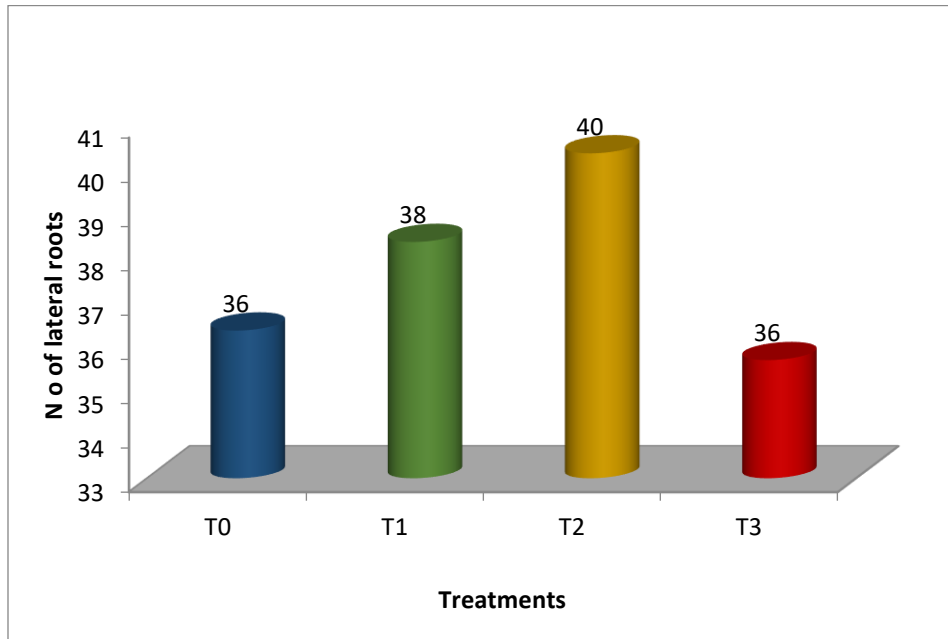
**Shoot length**

**Figure 37**



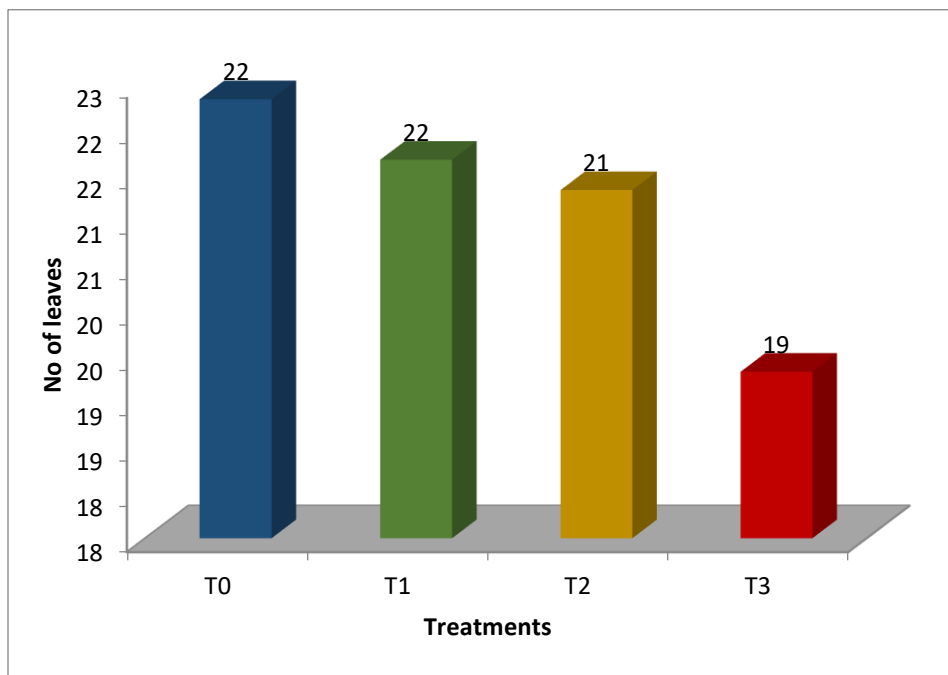
**Root length**

**Figure 38**



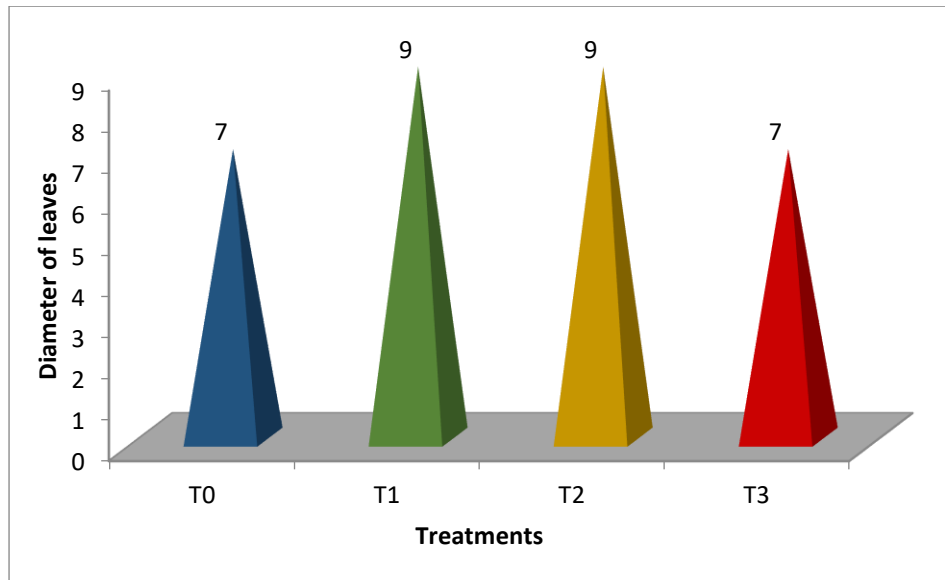
**Number of lateral roots**

**Figure 39**



**Number of leaves**

**Figure 40**



**Diameter of leaves**

The number of lateral roots was found to be maximum in plants treated with 200g Vermicompost (T<sub>2</sub>) on the 40<sup>th</sup> day and the value was  $40 \pm 1.2$  (Fig38.). Significantly higher number of leaves (Fig.39) and diameter of leaves (Fig.40) were observed in T<sub>0</sub> and T<sub>2</sub> on the 40<sup>th</sup> day and the values were found to be  $22 \pm 1.6$  and  $9 \pm 0.6$ cm respectively. T<sub>1</sub> also showed a diameter of  $9 \pm 0.1$  cm on 40 DAS.

**Plate 27**



**Flowering of plant after 40 days on vermicompost treatment**

Plate 27 shows buds and flowers from the plants that can be utilized for further growth. The flowers are observed 40<sup>th</sup> DAS. The first flower bud was seen in (T<sub>2</sub>) i.e., 200g of vermicompost concentration. Fruit was also seen after 55 DAS. (Plate 28)

**Plate 28**



**Fruit development after 55 days**

**Plate 29**



**Vermiwash acts as pesticide**

Earlier Govindapillai Seenan Rekha *et al.* (2018) have studied the effect of Vermicompost on morphological features of *Capsicum annuum* (Linn.) Hepper and showed that Vermicompost contains a combination of macro- and micro-nutrients and the uptake of these nutrients possesses a positive effect on the growth of the leaves of *Capsicum*.

Cavender *et al.* (2003) have shown that the addition of Vermicompost to substrates increases the N, P and K levels, thereby increasing the shoot and root dry weights in *Sorghum bicolor*.

The current study on the growth parameters of tomato plant using Vermicompost and Vermiwash application is in accordance with the earlier studies by Awadhpersad *et al.* (2021) on the combined application of Vermicompost and Vermiwash as a biofertilizer to tomato plant.

Arancon and Edwards (2005) have shown that thermophilic composting of organic wastes could eliminate some of the detrimental effects of organic wastes in the soil. Studies by Makkar *et al.* (2017) on the germination and yield of *Linum* sp. have shown that when foliar application of Vermiwash was integrated with Vermicompost improved the nutrient management in the crop thereby improving the seedling growth, plant growth and yield.

Earlier studies on the plant growth characteristics of cucumber by Sallaku *et al.* (2009) have reported that the Vermicompost is an appropriate growing media for vegetable seedling propagation and shown a higher growth rate and dry matter of cucumber seedlings at the nursery stage.

The work done by Akhgar and Sotodeh (2021) on the combined application of Vermicompost and growth-promoting bacteria have shown an increased yield and mineral content of sesame seeds.

Studies by Edwards *et al.* (2006) on the effect of Vermicompost on tomato plant growth have proved that the plants could have benefited from the growth hormones or from the hormones that had been absorbed during Vermicomposting onto the humic acids. They have reported that the microorganisms could pass into the teas during brewing giving enormous benefits to the plants.

The higher percentage of humic acids in Vermicompost helps in improving the plant health as it increases the synthesis of phenolic compounds such as anthocyanins and flavonoids that improves the quality of the plant and also act as a deterrent to pests and diseases.

Studies on the effect of soil type and Vermicompost application on tomato growth by Zucco *et al.* (2015) have shown that the sandy soil amended with Vermicompost generally increases the plant growth parameters compared to clay and loam soils.

Suthar (2008) have reported that the use of Vermicompost as an efficient plant growth media for garlic if applied with some combinations of NPK could act as a sustainable plant production media.

The results of the present study on the yield of tomato are in accordance with the study on the effect of Vermicompost on the growth of chilli pepper plant carried out by Narkhede *et al.* (2011)

## CHAPTER 5

### SUMMARY AND CONCLUSION

The experiment was conducted in tomato plant (*Solanum lycopersicum* L.) using Vermicompost and Vermiwash at different concentrations against untreated control to estimate the growth parameters of tomato plant.

The germination and initial leaflet formation of the tomato plant was seen after 7 to 14 days of growth. The parameters tested for morphological characters were shoot length, root length, number of lateral roots, number of leaves and diameter of leaves on the 10<sup>th</sup>, 20<sup>th</sup>, 30<sup>th</sup> and 40<sup>th</sup> day after sowing.

On the 10<sup>th</sup> and 20<sup>th</sup> day after using Vermiwash, the shoot length seemed to increase significantly in T<sub>2</sub> (200ml) and T<sub>1</sub> (100ml) concentration. The root length and the number of leaves on the 10<sup>th</sup> and 20<sup>th</sup> day were found to be significantly higher in T<sub>2</sub> (200ml) and T<sub>1</sub> (100ml) Vermiwash applied plants. The number of lateral roots formed, and diameter of the leaves were more in T<sub>1</sub> (100ml) and T<sub>2</sub> (200ml) treated plants on the 10<sup>th</sup> and 20<sup>th</sup> day. Likewise, on the 10<sup>th</sup> and 20<sup>th</sup> day on using Vermicompost, the shoot length seemed to be significantly higher in T<sub>2</sub> (200g) and T<sub>1</sub> (100g) concentration. The root length and the number of leaves on the 10<sup>th</sup> and 20<sup>th</sup> day were found to be significantly higher in T<sub>2</sub> (200g) and T<sub>1</sub> (100g) Vermicompost applied plants. The number of lateral roots formed, and diameter of the leaves were more in T<sub>1</sub> (100g) and T<sub>2</sub> (200g) treated plants on the 10<sup>th</sup> and 20<sup>th</sup> day.

On the 30<sup>th</sup> day, after using Vermiwash, the shoot length was found to be significantly higher in T<sub>2</sub> (200ml) concentration. The root length on 30<sup>th</sup> day was found to be significantly higher in T<sub>3</sub> (300ml) Vermiwash applied plants. The number of lateral roots formed and number of leaves produced were more in T<sub>2</sub> (200ml) treated plants. The diameter of leaves were more in T<sub>3</sub> (300ml). Likewise, on the 30<sup>th</sup> day on using Vermicompost, the shoot length was found to be significantly higher in both T<sub>2</sub> (200g) and T<sub>3</sub> (300g) concentration. The root length and the number of leaves on the 30<sup>th</sup> day were found to be significantly higher in T<sub>3</sub> (300g) and T<sub>0</sub> (Control plants). The number of lateral roots formed and diameter of the leaves were more in T<sub>2</sub> (200g) and T<sub>3</sub> (300g) treated plants on the 30<sup>th</sup> day.

On the 40<sup>th</sup> day, after using Vermiwash, the shoot length increased significantly in T<sub>2</sub> (200ml) concentration. The root length on 40<sup>th</sup> day was found to be significantly higher in T<sub>1</sub> (100ml) Vermiwash applied plants. The number of lateral roots formed and number of leaves were more in T<sub>2</sub> (200ml) and T<sub>0</sub> control plants. The diameter of leaves were more in T<sub>2</sub> (200ml). Similarly, on the 40<sup>th</sup> day, using Vermicompost, the shoot length seemed to have increased significantly in T<sub>1</sub> (100g) concentration. The root length and the number of lateral roots formed on the 40<sup>th</sup> day were found to be significantly higher in T<sub>2</sub> (200g) Vermicompost applied plants. The number of leaves and diameter of the leaves were more in T<sub>2</sub> (200g) and T<sub>0</sub> control plants on the 40<sup>th</sup> day.

It is observed that the application of Vermiwash helps in improving the lifecycle of tomato plant (*Solanum lycopersicum* L.) as it is a liquid fertilizer and helps the root system to absorb quickly and supply to the shoot system and also acts as a pest control in controlling the pests like Serpentine leaf miner, Gram pod borer, Tobacco caterpillar, Whitefly, Spider mites, Root-knot nematode, IPM for Tomato. Vermicompost helps in stimulating the plant growth and yield of tomato plant.

Vermicompost could be exploited as a potent biofertilizer. The application of vermicompost and Vermiwash could improve the net production of the crop and thus save the cultivable lands from chemical fertilizers and pollution. The preparation of Vermicompost and Vermiwash from organic wastes is a cost-effective process and this could help in solving the unemployment problem.

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