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Soilless Vegetable Cultivation by Using Different Organic Nutrient Solutions

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Abstract

Soilless culture is rapidly gaining momentum and popularity and fastest growing sector of agriculture. Soilless culture provide maximum yield can be achieved as optimum conditions required for plants growth is maintained throughout the period and cost of production can be reduced as soil conservation, watering, weeding etc. In this study focused on soilless culture technique for crop production. It has great opportunities to explore the inabilities of production constraints involving environmental controls. Modification of culture methods and culture environment can lead to sustainable crop production desirable for human beings. Nutrient solutions are important factors in soilless cultivation. In this study, introduced some organic nutrient solution for soilless vegetable cultivation; there are waste tea solution (WTS), cow dung solution (CDS), aquaculture waste solution (AWS) and rice soup solution (RS) are compared with the control solution (CS). The maximum yield was recorded for WTS, CDS, WAC treated plants in both tomato and ladies' finger. Soilless substrates either having organic or inorganic ingredients have been used as for finding suitable growing media for horticultural crop production. In this study coco peat was used as growing medium. The study can be concluded that soil is not an ultimate substrate for effective plant growth medium and it is reported that, the selected nutrient solutions are much better in cultivation of vegetables. These are useful for different crop production under soilless cultivation and these are better option and peoples need to be aware about the importance of soilless vegetable cultivation.

Key words: Aquaculture, Crop production, Environmental controls

Introduction

In soilless agriculture, crops are grown in nutrient solutions. This is a popular way to plants that reduces the risk of crops being exposed to pest and harsh weather conditions. Soilless agriculture does not require the use of toxic chemicals. Unlike soil-based agriculture, where farmers have to use fertilizers to increase crop yield and spray pesticides to keep weeds and pest away, crops are somewhat protected from pest and weeds. Soilless culture is ideal in urban areas where space is too limited for soil-based gardens. Nutrient and growing media loss is significantly reduced with soilless cultivation because the nutrient requirements for crops are determined in advance. Soilless cultivation is believed less pollution.Compared to traditional farming, the yield from soilless cultivation are significantly higher as a result of intensive practices and the possibilities of continuous, year-round production. Soilless cultivation is not affected by environmental changes, and it conserves water and land. In traditional farming, water is absorbed into the ground and a significant portion of the water consumed is not actually benefiting the plant directly. This type of controlled and soilless growing environment, the amount of water consumed can be not only monitored but controlled to efficiently utilize only what's need. The use of agrichemicals in industrialized agriculture is a major concern to consumers today. The uncertainly of the side effects of consuming these chemicals has people around the world looking towards alternate food choices. This type of soilless farming there is less or no need for potentially toxic pesticides and chemicals, and it consider a better choice for both personal and environmental health. Clean environment can be maintained, as no soil is involved as in the case of traditional farming, and no threats from soil borne pathogens. Cost of production can be reduced as soil conservation, weeding etc. are not involved. In this study introduce attractive system of farming especially for young generation.

Materials and methods

Five nutrient solutions were used for this analysis namely and it was prepared by different concentrations, Waste tea solution **(WTS)** [25g of tea waste+250ml water].Cow dung solution **(CDS)** [25g cow dung+250ml water],Rice soup solution **(RS)** [25ml rice soup solution+250ml water] Waste water solution from aquaculture **(WAC)** [25ml waste aquaculture water 250 mlwater] and well water **[CS]**.The grow bag were

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prepared by using coco peat-graval mix as the substratum and the seeds of tomato (***Solanum lycopersicum)*** and ladies finger ***Abelmoschus esculentus*** collected from College of Agriculture, Vellayani. The seeds were sown on prepared beds atleast 2 seeds per hole.

pH were measured by electrometric determination. Conductivity was measured by using conductivity meter and the results were represented by ms/cm. Nitrate is estimated by brucine method spectrometric ally at 410 nm. Phosphate was determined by stannous chloride using spectrophotometric method. Flame photometer used to determine the concentration of potassium analysis, prepare various standard potassium solutions of different strengths by diluting this stock solution with distilled water.

Result and Discussion

In the present study, the conventional agricultural practice such as cultivation with soil were replaced by adopting soilless cultivation. On this study the sustainable practice of adding different organic nutrient solutions for the growth and development of plants and to produce quality vegetables in soilless cultivation. As a result all such practices revealed that it should effective than traditional cultivation. In this study,the common vegetables like tomato (***Solanum lycopersicum)*** and lady finger (***Abelmoschus esculantus.L***) were planted in coco peat grow bags and selected nutrient solutions were supplied at regular intervals and are compared with the control as treatment with water. Before the treatment, physical and chemical characteristics of each nutrient solutions were analyzed and after the treatment the morphological characteristic of each plants , the plant growth, rate of yield, disease resistant capacity were studied.All the results were illustrated in tables and graphs.It is very useful in urban areas since it requires limited space and low cost.The physico-chemical parameters anlyzed are pH, EC and NPK and the continuous monitorin of morphometric characteristics such as number of leaves,stem length, number of flowers and fruits.

Physico-chemical analysis of nutrient solutions

In this study the variation of pH in nutrient solutions are (Table 1& graph 1) control solution (CS) 7.18,waste tea solution (WTS) 6.16, cowdung solution (CDS) 6.80, Aquaculture waste solution (AWS) 6.52, ricesoup solution (RS)-4.12.It is observed there is a slight variation in pH that indicates microorganisms tend to modify their environment by the process of decomposition the matter pH changes over time.Among these solutions the pH of the rice soup became acidic and the remaining solutions nearly to neutral. This finding is in agreement with the studies of (Nakasaki et al .,1993), reported that the range of pH values suitable for bacterial development is 6.0-7.5, while fungi prefer an environment in the range of pH 5.5-8.0.Plant growth and development are greatly influenced by alterations of pH in the root environment (Islam et al., 1980).

The EC of nutrient solution shows (Table1&graph 2) control solution (CS) 83.37, waste tea solution (WTS) 128.5, cowdung solution (CDS) 129.4, Aquaculture waste solution (AWS) 168.5,Ricesoup solution (RS) 309.1 Electrical conductivity values cannot used as measure of nutrient levels for managing the culture solutions, owing to the ionic imbalance and depletion caused by rapid uptake of NO_3^- and K^+ from the nutrient solution (Takano.,1988). However, Ho & Adams (1995) stated that the most practical method for adjusting the nutrient supply in relation to demand in hydroponic systems is measuring the total ionic concentration of the solution as the electrical concentration in the root zone.

By analysing NPK ratio of the selected nutrient solutions revealed that control solution (CS) as 0.43:0.05:0.4,waste tea solution (WTS) 0.91:6.5:1.7,cowdung solution (CDS) 0.80:7.8:1.8, aqua culture waste solution (AWS) 0.86:4.5:0.8 and rice soup solution (RS) 0.93:8.1:4.8.Among these results by considering the nitrate concentration the control solution have much greater as compared to other solutions but remaining are more or less similar (Table 1 & graph 3). Nitrogen is a factor in many biological compounds that plays a major role in photosynthetic activity and also acts as parts of the enzymes associated with chlorophyll manufacturing which reflect relative crop nitrogen status present in the plants, and it is a building block of proteins and is highly considered necessary for all enzymatic reactions in a plants, Hokmalipour (2011). In the case of phosphate concentration is high in rice soup solution (RS) and low concentration were observed in control solution but waste tea solution (WTS) and aquaculture waste solution (AWS) is almost similar.Apart from control solution ,all others are with slight variations (Table 2&graph 4). It aids the plants in root development for smooth nutrients uptake, plants stalk and stem vitality, flower and seed creation, crop maturity and resistance to plant pests and diseases,Connolly, et al (1986). George, (1995) reported that the major factor limiting plant growth and development to be the rate at which phosphorus regulates photosynthesis and carbohydrate metabolism in plant leaves.

Then the concentration of potassium is high in rice soup solution and low was observed in control solution and others with also slight difference (Table 3&graph 4). Potassium is a highly mobile element in the plant and is translocated from the older to younger tissue. It also plays a key function in chlorophyll formation, the control of pH in the cells of the plants, and activates a number of enzymes,Vanbel, (1990).

Morphometric Studies

The morphometric studies revealed the performance of plant growth and development from the germination to harvest.It includes number of leaves,stem length, number of flowers and yield.

Number of leaves

In the 1st week, the number of leaves observed in the cultivated tomato plants including control plants 2 leaves .2nd week 4 leaves, but 3rd and 4th week change this continuity. In the 4th week AWS treated tomato plants produce 11 leaves, and CDS-10, WTS-8, CS-8, RS-6. 5th

and 6th week the number of leaves in WTS, CDS, AWS, treated tomato plants is greater than compared to control plants, however the RS treated plants produce less leaves, and it equal to the CS treated plant. Number of leaves in tomato plants 6th week, WTS-23, CDS-24, AWS-24, RS-15 and CS-15 shows (Table 2, Graph 6-9). Number of leaves in ladies finger,1st week WTS, CDS, treated plants shows 3 leaves and RS, AWS, CS, treated plants shows 2 leaves. 2nd week WTS, CDS, treated plants shows 4 leaves and RS, AWS, CS treated plants shows 3 leaves. 3rd week WTS, CDS treated plants shows 6 leaves and AWS treated plant shows 5 leaves, RS treated plant shows 4 leaves, but CS treated plants shows only 3 leaves. 4th week thus 6th week WTS treated plants shows 10 leaves and CDS, AWS treated plants shows 9 leaves , RS, CS treated plants shows only 8 leaves.Increasing the number of leaves depends upon the concentration of potassium (9-10%) in leaf dry matter associated with good growth. But this report is diagreed by the result of ricesoup treated solution potassium supplies must be sufficient to produce leaf concentrations of about 9-10% Knave, (1981).

Stem length

The stem length of different nutrient solutions treated plants compared with control plants shows ,in the first week tomato plant stem length is CDS-5, WTS-4.8, , RS-4.1, AWS-4.6 and CS-4.2, 2nd week WTS-5.9, CDS-6.1, RS-4.9, AWS-5.9, and CS-5.2. After 2 weeks nutrient solution treated tomato plants stem length is WTS-29.4, CDS-30.1, RS-20.3, AWS-29.4, and CS-22.4. It shows WTS, CDS, AWS treated plant growth is higher than RS and CS treated plants. 6th week WTS, CDS, AWS treated plants shows good growth 40.1, 41.6, 38.6 respectively. RS treated plants stem length is 24.2, CS treated plant is 26.6.In the first week nutrient solution treated ladies finger plants stem length is WTS-9.8, CDS-9, RS-8.6, AWS-9.1 and CS-8.2, 2nd week WTS-13.2, CDS-10.9, RS-10.1, WAC-11.2, and CS-10.1(Table 2, Graph 10-13). After 2 weeks nutrient solution treated ladies finger plants stem length is WTS-25.5, CDS-19, RS-20.6, AWS-22.1, and CS-18.3. It shows WTS, AWS treated plant growth is higher than CDS, RS and CS treated plants. 6th week WTS, CDS, AWS treated plants shows good growth 28.6, 24.9, 25.6 respectively. RS treated plants stem length is 22.3, CS treated plant is 20.1.

Flowering and yielding

In this study shows a positive effect of nutrient solution that resulted the greater yield in vegetable plants (Table 2, graph 14-17).The first flowering started in CDS treated tomato plant, but in the case of ladies finger flowers appeared in the same time in WTS, CDS, RS, AWS treated plants except in control. Highest number of flowers in tomato plant is WTS-8, CDS-8, and AWS-4 respectively and ladies finger plant is WTS-4, CDS-3, and AWS-3. Considering the yield WTS and CDS treated tomato plants produce fruits in same week it gives 3 and 2 and after 2 weeks all the nutrient solution treated tomato plants produce fruits. But CS treated plant not produce fruits. WTS and CDS treated plants produce fruits in same week it gives 2 and 1 fruits in ladies finger. After 2 weeks all the nutrient solution treated ladies finger produce fruits. But CS treated plant produce one fruits after one week, but it not a healthy fruit. WTS, CDS, AWS treated plants give great yield than RS in both and tomato plant ladies finger.Among all these nutrient solutions WTS, CDS, AWS treated plants given greater yield than CS. Wide evaluation of plant yield obtained in soilless systems with an emphasis on its quality and the need to use closed fertigation systems in horticultural practice was presented in the review by Gruda (2009).Flowering was accelerated by application of high nitrogen concentrations, and length of the last internode and total stem length were decreased, Choi et al (1997). Cefola et al, (2011) shows some aspects of quality of vegetables produced under soilless cultivation have early been improved, such as a decrease in phytosanitary residues, enhanced organoleptic characteristics and longer shelf life.

Plant growth

The result of the treatment of nutrient solution on the growth analysis both plant species are presented in Table 2 showed that the positive effects of nutrient solutions on plant growth. While treared with both solutions nutrient as well as control solution, the nutrient solution treated plants shows more growth efficiency.Thus the growth and yield performance in organic nutrient solution treated plants also significantly higher than the control. WTS, CDS, and AWS treated plants produce greater yield. These are the easily available nutrient solution. So WTS, CDS, and AWS treating soilless culture are more significant in urban farming. Plant growth is one of the major factor determined the efficiency of nutrient solutions.Variation in nutrient solution concentrations and environmental conditions with increasing mean daily temperature causes changes in the ratio of nutrient and water uptake and these are affected by growth and development of the plants (Klaring et al, (1997).

Disease resistant

In this study observed that the nutrient solution treated plants have disease resistant capacity ascompared to the CS. The highest visual quality in healthy appearance was observed in WTS, AWS, and CDS treated plants and lowest were observed in CS treated plants. But in the case of controlled solution it has poor disease resistant capacity and at the time of yield the plants are suddenly damaged .Application of cow dung in proper and sustainable way can enhance not only productive of yield but also minimizing the chance of diseases, Abhishek, (2014) and it is agreed to this study observed better quality in cow dung solution treated plants.

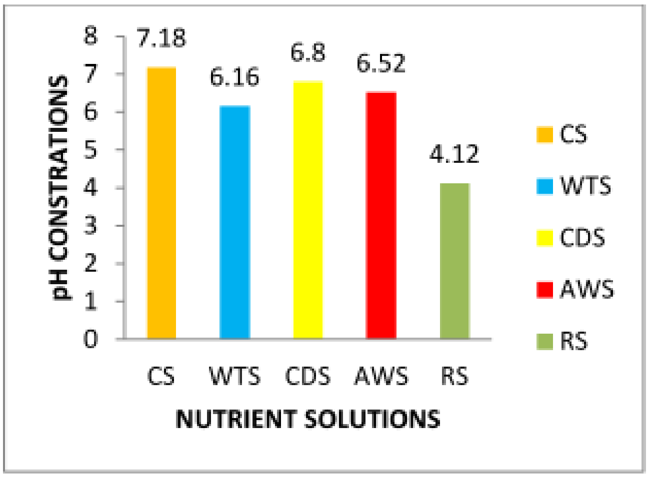
In this study shows the nutrient solutions are more effective than control solution. The control solution (CS) has low NPK concentration for development of plant, so it does not produce fruits and the flowers of control solution treated plants are falling before fruit development.Here rice soup solution (RS) is acidic in nature,but other nutrients such as NPK concentration was observed nearer to the other nutrient solutions,so it does not produced greater yield. Waste tea solution (WTS), cow dung solution (CDS) and aquaculture waste solution (AWS) are having much nutrients and these treated plants showed better and completed the growth and develpoment stages.

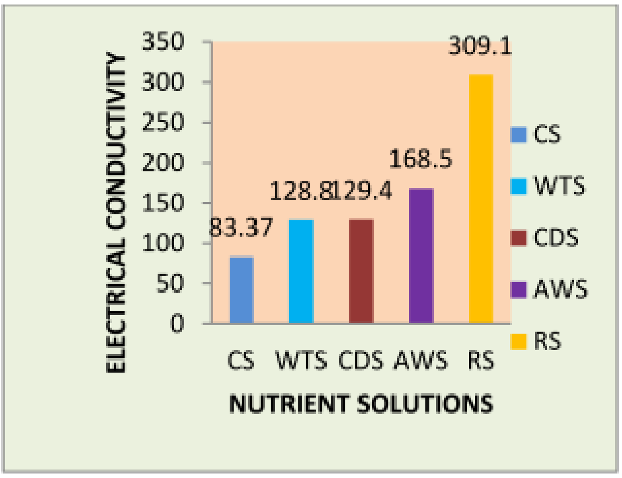
Table: 1. Chemical Analysis of Nutrient Solutions

SI.NO	SOLUTIONS	P^{H}	EC	N(mg/l)	P(mg/l)	K(mg/l)
1	Control water	7.18	83.37	0.43	1.2	0.9
2	Waste tea solution	6.16	128.8	0.91	6.5	1.7
3	Cow dung solution	6.80	129.4	0.86	4.5	0.8
4	Aquaculture waste solution	6.52	168.5	0.8	7.8	1.8
5	Rice soup solution	4.12	309.1	0.93	8.1	4.8

Table 2: Plant growth by treating diffferent nutrient solutions

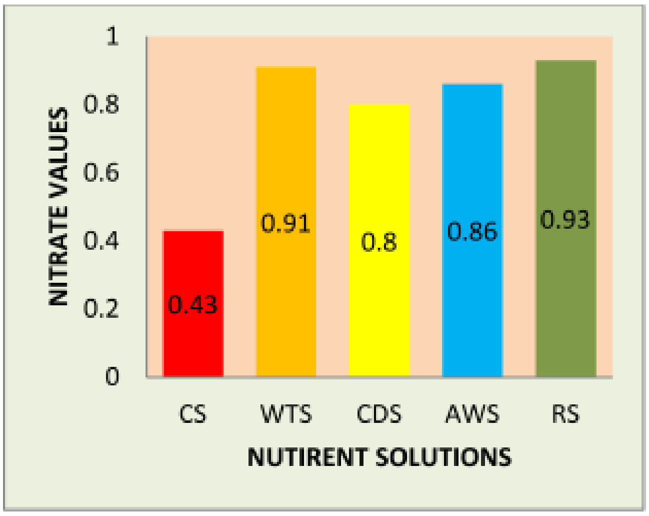
PLANT SPECIES										
	TOMATO					LADIES FINGER				
MORPHOLOGICAL CHARACTERS	WTS	CDS	AWS	RS	CS	WTS	CDS	AWS	RS	CS
NUMBER OF LEAVES										
1st week19.03.2016	3	3	3	3	3	3	3	2	2	2
2nd week26.03.2016	4	4	4	4	4	4	4	3	3	3
3rd week02.04.2016	7	7	7	6	6	5	5	5	4	3
4th week09.04.2016	8	10	11	6	8	6	6	6	5	5
5th week16.04.2016	14	18	18	10	13	6	6	5	4	4
6th week23.04.2016	23	24	24	15	15	10	9	9	8	8
STEM LENGTH										
1st week19.03.2016	4.8	5	4.6	4.1	4.2	9.8	9	9.1	8.6	8.2
2nd week26.03.2016	5.9	6.1	5.9	4.9	5.2	13.2	10.9	11.2	10.1	10.1
3rd week02.04.2016	9.9	10.2	10.4	6.9	8.3	18.6	14.4	16.5	13.4	13.2
4th week09.04.2016	16.2	17.1	15	12.4	13.4	20.4	16.5	18.9	17.4	16.2
5th week16.04.2016	29.4	30.1	29.4	20.3	22.4	25.5	19	22.1	20.6	18.3
6th week23.04.2016	40.1	41.6	38.6	24.2	26.6	28.6	24.9	25.6	22.3	20.1
NUMBER OF FLOWERS										
07.05.2016	0	3	0	0	0	2	2	2	1	0
14.05.2016	3	4	3	0	0	3	2	3	1	0
21.05.2016	6	8	6	3	3	2	3	2	1	1
28.05.2016	6	8	6	3	5	3	3	2	2	0
04.06.2016	8	8	4	3	3	4	3	3	2	2
YEILD TIME										
1st week	3	2	0	0	0	2	1	0	0	0
2nd week	5	5	1	1	0	2	2	1	0	0
3rd week	5	5	3	2	0	3	2	2	1	0
4th week	7	6	4	2	0	4	3	3	1	1

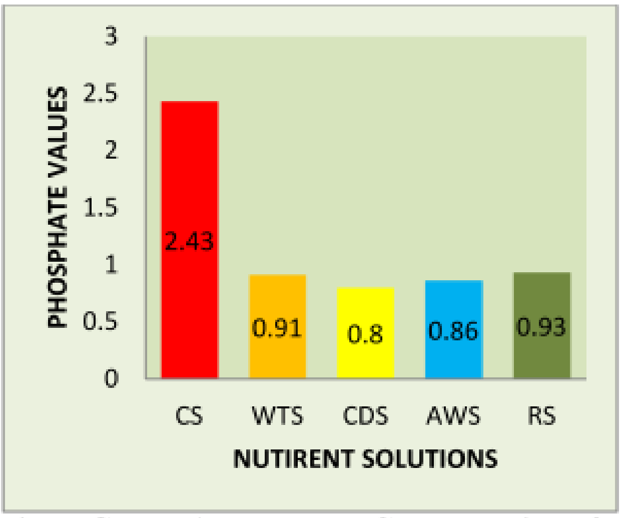




Graph-1: pH of Nutrient Solutions

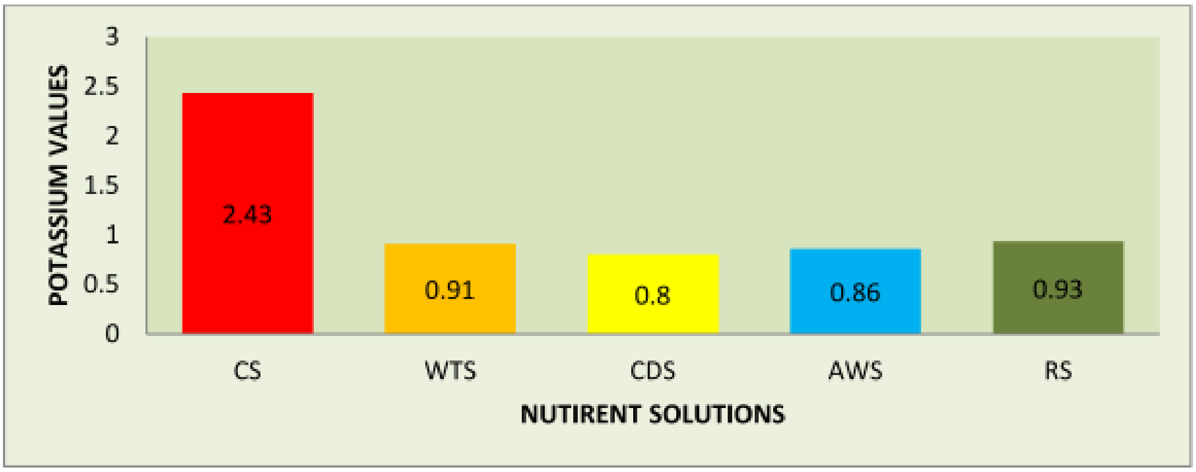
Graph-2: EC of Nutrient Solutions



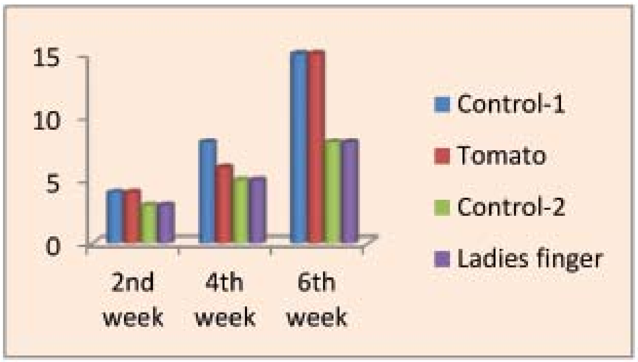


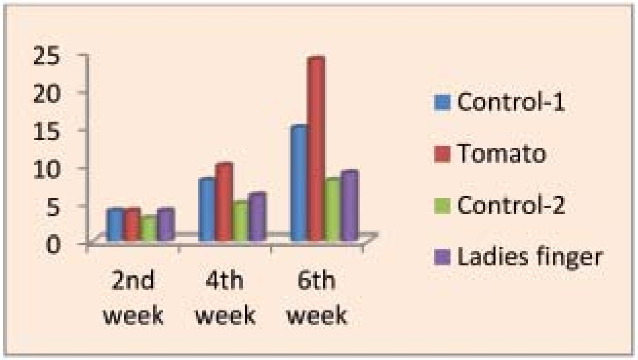
Graph-3: Nitrate Concentration of Nutirent Solutions

Graph-4: Phosphate Concentration of Nutirent Solutions



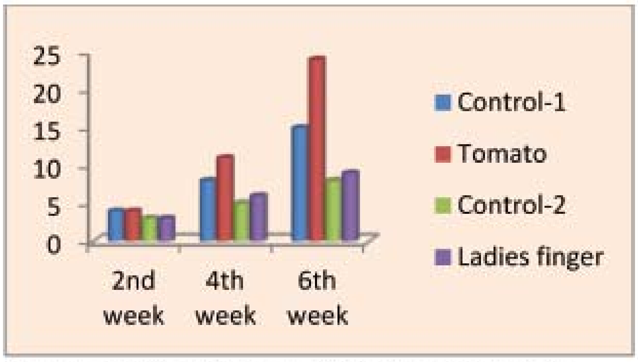
Graph- 5: Potassium Concentration of Nutirent Solution

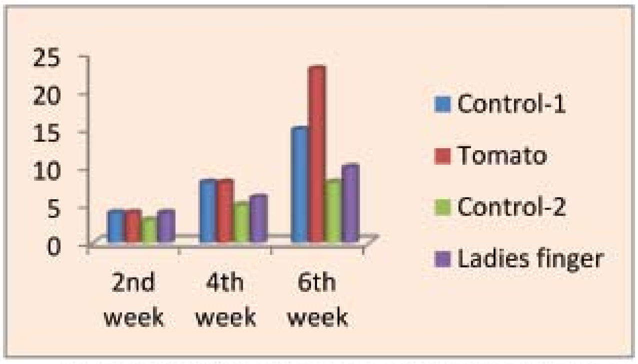




Graph-6: No.of leaves WTS treated plants

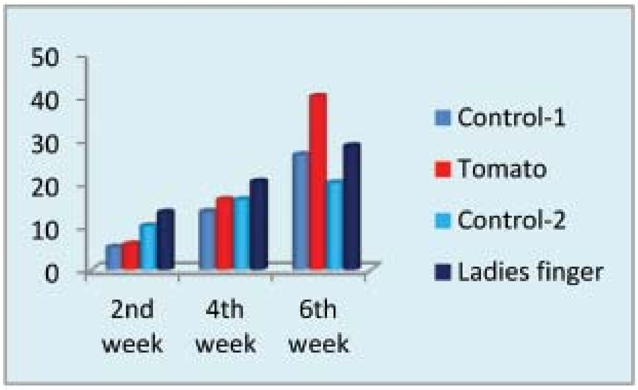
Graph-7: No.of leaves CDS treated plants

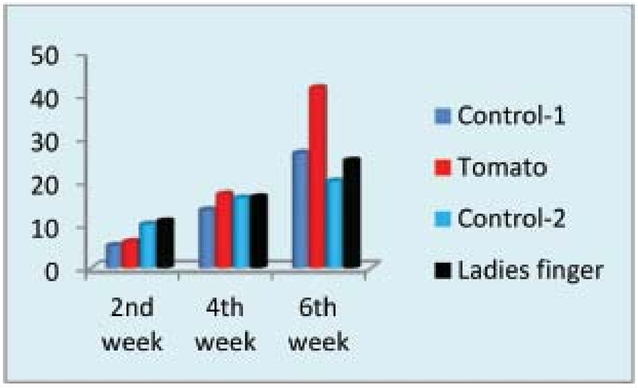




Graph-8: No.of leaves AWS treated plant

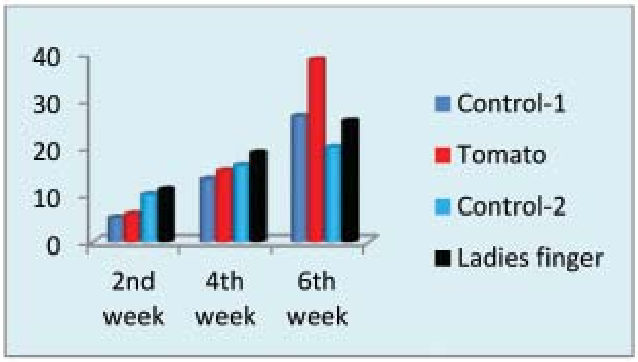
Graph-9: No.of leaves RS treated plants

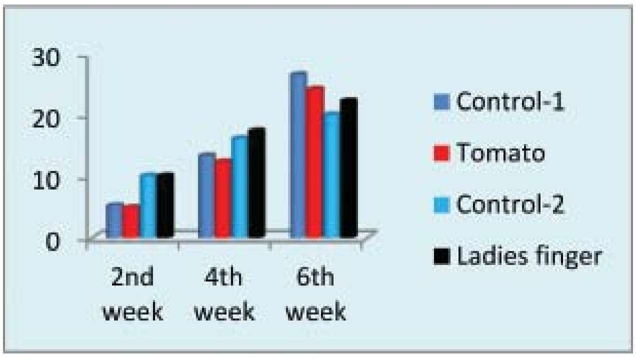




Graph-10: Stem length on WTS treated plant plant

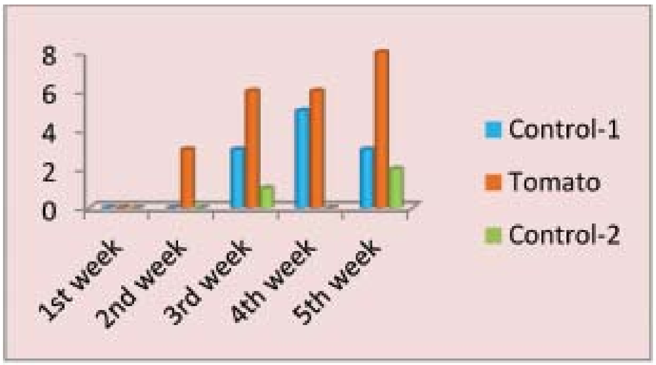
Graph-11: Stem length on CDS treated

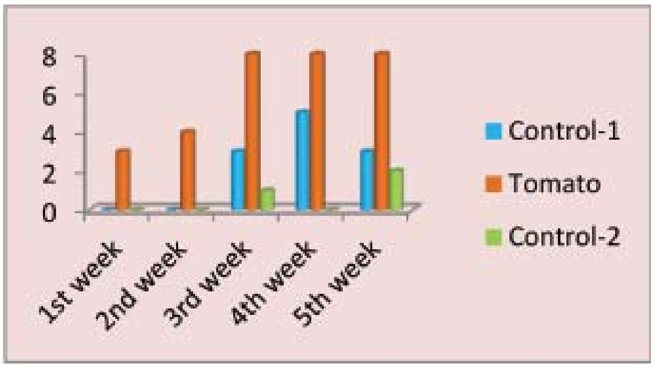




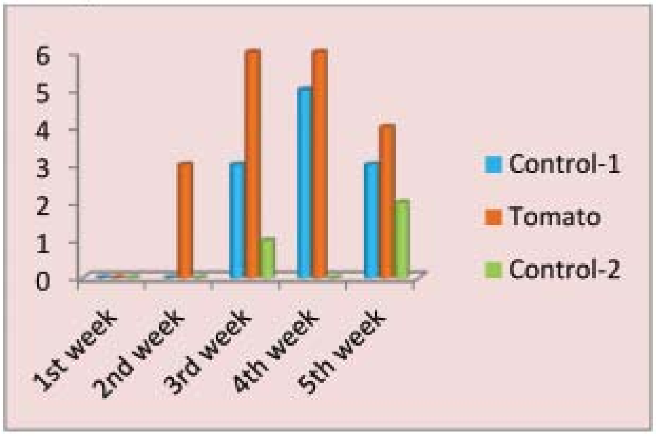
Graph-12: Stem length on AWS treated plant

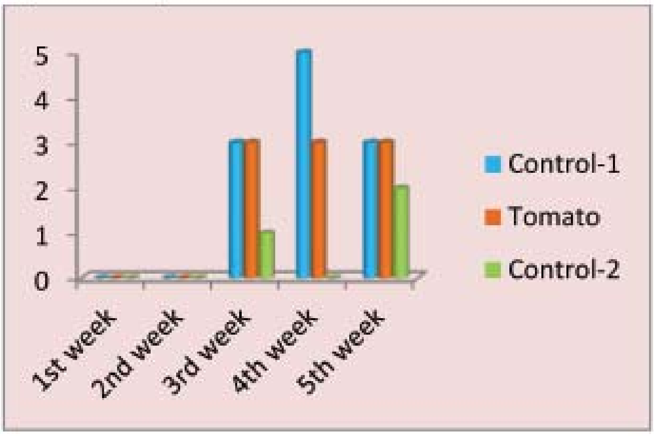
Graph13: Stem length on RS treated plant



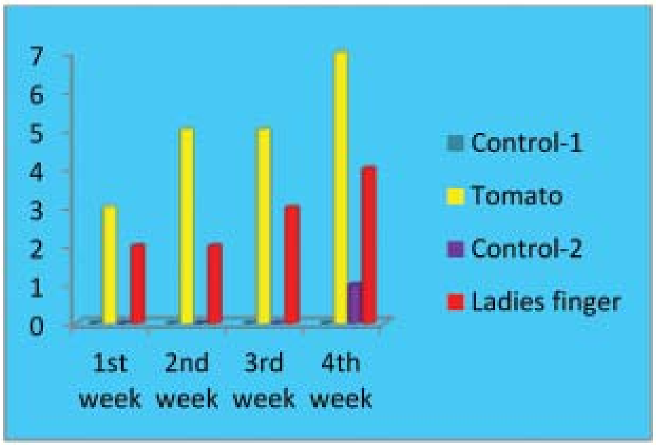


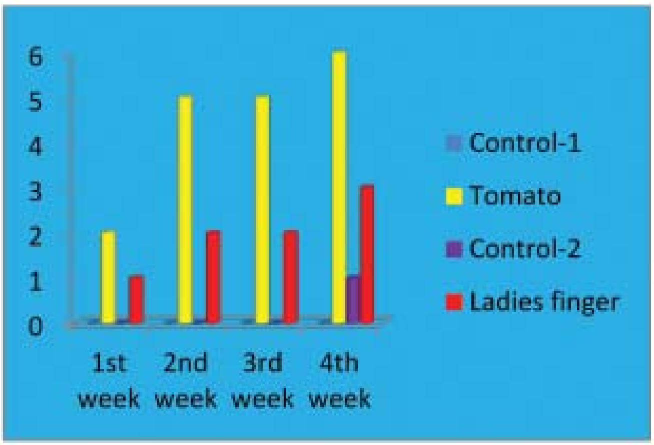
Graph-14: Number of flowers on WTS treated plant Graph-15: Number of flowers on CDS



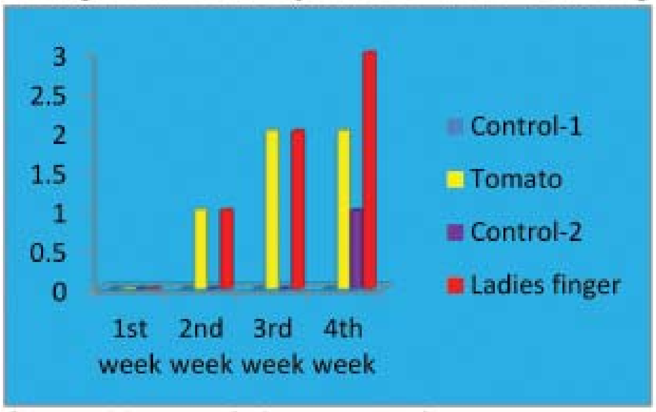


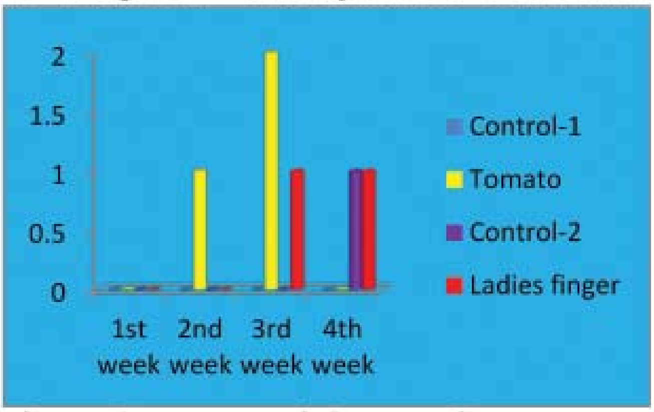
Graph-16: Number of flowers on AWS treated Graph-17:Number of flowers on RS treated plant





Graph-18: No.of yield on WTS treated plan Graph-19: No.of yield on CDS treated





Graph-20: No.of yield on AWS treated plants Graph-21:Number of yield on RS treated

Summary and Conclusion

Soilless culture technique has been used successfully in the production of difficult to grown plants. It has great opportunities to explore the inabilities of production constraints involving environmental controls. Modification of culture methods and culture environment can lead to sustainable crop production desirable for human beings. Soilless culture is rapidly gaining momentum and populaty and fastest growing sector of agriculture. Soilless culture provide maximum yield can be achieved as optimum conditions required for plants growth is maintained throughout the period and cost of production can be reduced as soil conservation, watering, weeding etc are not involved.

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The study can be concluded that soil is not an ultimate substrate for effective plant growth medium and it is reported that,the selected nutrient solutions are much better in cultivation of vegetables.These are useful for different crop production under soilless cultivation and these are better option and peoples need to be aware about the importance of soilless vegetable cultivation.

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