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Short communication

Hydroponic cultivation of tomatoes - An attempt for Kerala conditions

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Abstract

The tomato variety Anagha was raised in Deep Flow Technique and Ebb and Flow Technique (flood and drain system) at Department of Olericulture, College of Horticulture, Vellanikkara to evaluate the performance of crops under hydroponics and the same was compared with crops raised in soil (control). The ideal growing media (coco peat, expanded clay pellets and pebbles) on crop growth, yield and fruit quality was also studied in the present investigation. The results revealed that the performance of control plants were superior to hydroponic plants. Out of the two hydroponic methods, Ebb and Flow Technique showed better vegetative growth and yield per plant whereas Deep Flow Technique exhibited efficient utilization of vertical space, higher planting density and higher yield per unit area. Out of the three growing media plants grown in coco peat medium performed the best, followed by those in pebbles. Performance of plants grown in expanded clay pellets was very poor. Fruit quality in terms of total soluble solid content and titrable acidity was not significantly affected by the hydroponic treatments.

Keywords: Coco peat, Deep Flow Technique, Ebb and Flow Technique, Expanded clay pellets, Hydroponics, Tomato

Vegetables have a vital role in human diet. Since they provide the essential nutrients like vitamins and minerals, they are known to be the protective food. Among vegetables, tomatoes have worldwide popularity; they are low in calorie, fat and cholesterol. Tomato is a crop of high demand throughout the world due its versatility during all seasons. The increasing problems of soil borne diseases such as damping-off, root rots (*Pythium ultimum*, *Rhizoctonia solani*, *Phytophthora* spp.), wilts (*Fusarium oxysporum* and *Verticillium dahliae*) and pests (borer pests, sucking pests, aphids etc.) make the conventional cultivation of tomato a bit difficult (Stirling et al., 2016). Along with these, unavailability of productive land and shortage of irrigation water have emerged as important constraints. Due to urbanization and industrialization most of the land get degraded and also loses its fertile top soil. In these circumstances modern production techniques like hydroponics gain importance.

Hydroponics is an efficient technology for growing plants in nutrient solutions (water containing fertilizers), with or without the use of an artificial medium (sand, gravel, vermiculite, rockwool, perlite, peatmoss, coir, or sawdust) (Jensen and Collins, 1985). The main attraction of hydroponics is that it does not demand any fertile soil for the production of crops. Since the soil is excluded from production process there will not be any problem related to soil borne diseases, pests and weeds. By the exclusion of these problems, there will be minimum usage of harmful plant protection

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chemicals, so the yield from hydroponics is fresh and healthy (Bogovic, 2011).

Nowadays, in Kerala, more people from urban areas are showing interest in modern techniques in agriculture. The changing health concern of people also demands high quality food. But in a state like Kerala, where there is severe shrinking of cultivable land and water, the production of fresh vegetables are great a challenge. All these necessitates the adoption of techniques which produce more yields from less area and which do not demand productive soil for cultivation. Hence a preliminary attempt was carried out to evaluate the performance of tomato plants under hydroponics.

The present investigation was carried out in the Department of Olericulture, College of Horticulture, Vellanikkara from September 2015 to January 2016. The objective of the study was to evaluate the performance of tomato plants under hydroponics in comparison to plants grown in soil and also to understand the ideal growing media for hydroponics. The experiment was laid out in a Completely Randomized Design (CRD). There were three replications and 15 plants per replication. Seeds of the semi determinate tomato variety Anagha were sown in protrays in September, 2015 and transplanted in October 2015. For understanding the ideal growing medium, three types of growing media were tested in Ebb and Flow Technique and Deep Flow Technique using Cooper's nutrient solution.

The Deep Flow Technique (DFT) was applied in a structure made of PVC pipes. Ten PVC pipes of 5m length and 7.5cm diameter each were arranged in three tiers using GI frame. In each pipe there were 15 holes, with a total of 150 holes for holding plants in DFT. The seedlings were first transplanted into plastic pots filled with diferent media (coco peat, expanded clay pellets and pebbles), and then they were placed in the PVC pipe structure. Cooper's nutrient solution was continuously cycled through the pipes for 20 minutes, followed by 10 minutes off time. There was a timer system to control the flow rate, the 'ON' time was 20 minutes and 'OFF' time was 10 minutes. Fresh solutions were added in to the main tank at two weeks interval.

In Ebb and Flow technique, seedlings were directly transplanted into brick structures filled with different growing media. There were five rows and ten plants in each row, with a total of 50 plants in each structure. The nutrient solution was pumped into the structure in such a manner that it completely flooded the medium for 20 minutes. Then the nutrient solution was drained back into the main tank and the process was repeated continuously. The flood and drain time was controlled by a timer, for which the 'ON' time was 20 minutes and 'OFF' time was 10 minutes. Observations on growth characters, yield characters and quality characters were taken from the experimental plants during the course of experiment.

Treatment details

F_1 – Deep Flow Technique
F_2 – Ebb and Flow Technique
S – Cooper's nutrient solution
M_1 – Coco peat medium
M_2 – Expanded clay pellet medium
M_3 – Pebble medium

Treatment combinations

F_1SM_1 - Deep Flow Technique + Cooper's nutrient solution + Coco peat medium
F_1SM_2 - Deep Flow Technique + Cooper's nutrient solution + Expanded clay pellet medium
F_1SM_3 - Deep Flow Technique + Cooper's nutrient solution + Pebble medium
F_2 S M_1 – Ebb and Flow Technique + Cooper's solution + Coco peat medium
F_2 S M_2 – Ebb and Flow Technique + Cooper's solution + Expanded clay pellet medium
F_2 S M_3 – Ebb and Flow Technique + Cooper's solution + Pebble medium
Control – Plants in soil

The data on growth characters are presented in Table 1. The plant height was the greatest in control (71.66

Table 1. Effect of hydroponics and growing media on growth characters of tomato

Treatments	Plant height at 50^{th} day (cm)	Days to first flower appearance	Days to first fruit set	Days to first harvest	Duration of the crop
F_1SM_1	63.03	24.76	28.76	56.33	83.03
F_1SM_2	48.53	27.46	30.46	59.26	78.50
F_1SM_3	60.30	25.63	28.63	56.40	81.96
F_2SM_1	69.36	22.06	25.73	51.73	85.73
F_2SM_2	63	25.73	29.40	56.06	82.50
F_2SM_3	66.40	24.36	27.70	54.40	84.13
Control	71.66	19.83	23.16	48.20	88.50
CD (0.05)	2.21	1.23	1.30	1.57	1.12

cm) at 50 days after transplanting. This was followed by plants in Ebb and Flow Technique with coco peat as growing medium (F_2SM_1 – 69.36 cm). The height was lowest in Deep Flow Technique with expanded clay pellets (F_1SM_2 – 48.53 cm).

The least number of days to first flower appearance was observed in control (19.83 days), followed by Ebb and Flow Technique with coco peat medium (F_2SM_1 – 22.06 days). The days to first flower appearance was greater in Deep Flow Technique with expanded clay pellet medium (F_1SM_2 – 27. 46 days). Since the number of days to first flower appearance was the least in control, the days to first fruit set (23.16 days) and first harvest (48.20 days) were also the least in this treatment. This was followed by Ebb and Flow Technique with coco peat medium (F_2SM_1- days to first fruit set : 25.73 days, days to first harvest : 51.73 days). Plants raised in soil showed greater crop duration (88.50 days), followed by plants grown under Ebb and Flow Technique with coco peat medium (85.73 days).

The data on yield characters are presented in Table 2. The number of fruits per plant was highest in control (39.16). This was followed by Ebb and Flow Technique with coco peat medium (F_2SM_1 – 36.50). The fruits per plant was minimum in Deep Flow Technique with expanded clay pellet medium (F_1SM_2– 18.33). The number of harvests was the highest in Ebb and Flow Technique (F_2SM_1 –20.16). This was followed by control (19.66). The number of harvests was minimum in Deep Flow Technique (F_1SM_2 – 6.50). The highest yield per plant was recorded in control (2.08 kg). This was followed by Ebb and Flow Technique with coco peat medium (F_2SM_1 – 1.67 kg). The yield per plant was lowest in Deep Flow Technique with expanded clay pellet medium (F_1SM_2 – 0.37 kg). The highest yield per unit area was recorded in control (18.72 kg m^{-2}). Plants under Deep Flow Technique with coco peat medium (F_1SM_1 – 18.48 kg m^{-2}) was on par with that of control. The lowest yield per unit area was recorded in Ebb and Flow Technique with expanded clay pellet medium (F_2SM_2 – 4.59 kg m^{-2}).

The data on quality characters are presented in Table 3. The nature of growing techniques and growing

Table 2. Effect of hydroponics and growing media on yield characters on tomato

Treatments	Fruits per plant	Number of harvests	Yield per plant (kg)	Yield per unit area (kg m^{-2})
F_1SM_1	31.53	15.13	1.32	18.48
F_1SM_2	18.33	6.50	0.37	5.18
F_1SM_3	29.73	13.60	1.15	16.10
F_2SM_1	36.50	20.16	1.67	15.03
F_2SM_2	20.10	9.83	0.51	4.59
F_2SM_3	34.36	16.03	1.48	13.32
Control	39.16	19.66	2.08	18.72
CD (0.05)	1.30	0.97	0.05	0.92

Table 3. Effect of hydroponics and growing media on quality characters of tomato

Treatments	TSS (æ%Brix)	Acidity (%)
F_1SM_1	7.66	0.58
F_1SM_2	7.63	0.58
F_1SM_3	7.73	0.59
F_2SM_1	7.15	0.56
F_2SM_2	7.83	0.59
F_2SM_3	7.17	0.56
Control	6.43	0.63
CD (0.05)	0.56	0.07

media did not influence the TSS and acidity of fruits significantly. But there was significant difference between control and hydroponic treatments. The TSS of fruits from control plants was significantly lower than that of all other treatments. For the fruits from control the TSS was 6.43, and the TSS varied from 7.50 to 7.83 in all other treatments. The acidity was the highest in fruits obtained from control plants. In all other treatments there was no significant difference for acidity, and it varied from 0.56 per cent to 0.59 per cent.

The result showed that the control plants performed better than that of all other treatments because they were grown according to KAU package of practices recommendations which was already standardized for each crop, while in all other hydroponic treatments only specified amount of nutrient were supplied, which may not have been sufficient for all climatic conditions. Gruda (2009) reported that compared to soilless culture, tomatoes grown in soil showed a higher overall performance in terms of growth, yield and fruit quality, because the plants cultivated in soil had better capacity of recovery in case of any adverse situation, without any visible quality deficiencies. Out of the two techniques Ebb and Flow Technique was found to be superior to Deep Flow Technique with respect to vegetative growth, flowering, fruiting and yield per plant. It may be due to the better support and anchorage received by the plants from this method, similar to the soil environment. The roots were also very strong and attained a tap root nature as in soil here, whereas in Deep Flow Technique, roots were more or less fibrous in nature. Strefeler (1991) reported that out of the various hydroponic techniques like ebb and flow system, nutrient film technique, slab substrates system, closed recirculation floors, and pulse watering system, ebb and flow system was the best for vegetable production. Even though yield per plant was higher under Ebb and Flow Technique, the yield per unit area was the highest under Deep Flow Technique. In a unit area of 1 m^2, under Deep Flow Technique, 14 plants were accommodated, whereas in control and Ebb and Flow Technique there were only 9 plants. Out of the three growing media, coco peat was the best. The better performance of plants in coco peat medium may be due to its higher water holding capacity, aeration and high potassium content. The study carried out by Noguera et al. (2000) revealed that coconut waste was the best medium for growing horticultural crops under hydroponics. They observed that this medium was light weight and had high total porosity (94 per cent of total volume). Yau and Murphy (2000) reported that when composted coco peat was used as the growing medium for tomato plants under soilless culture, they produced higher number of fruits and higher total yield. When coconut fibre was used as the growing medium in hydroponics, tomato crop yielded the heaviest fruits (128 g) (Carrijo et al., 2004).

The above findings revealed that the growth and yield parameters of soil grown plants with POP recommendations were superior to hydroponically grown tomato plants. Since in control, the nutrients were applied according to standard POP recommendations, there was no chance for reduction in the performance of crops. Both the hydroponics methods showed promising results. In terms of vegetative growth, flowering, fruiting and yield per plant, Ebb and Flow Technique was better. But when yield per unit area was considered, Deep Flow Technique was the best. So, in areas having space constraints the latter technique is the best choice for cultivation due to its efficient utilization of vertical space. The former technique can be recommended in areas having enough space for cultivation but lacking fertile productive soil or experiencing drastic attack of soil borne pathogens. The growth and yield parameters were observed to be higher in coco peat medium, followed by pebbles. In expanded clay pellets, plants were less vigorous. The higher potassium content and better water holding capacity of coco peat medium significantly influenced the performance of plants under hydroponics.

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