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STUDY ON THE HYDROPONIC SYSTEM FOR SUSTAINABLE FARMING OF LEAFY VEGETABLE CROPS

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Abstract

The food production demand is increasing according to the world population growth rate, and the traditional farming system will not be able to fulfill the need of growing demand for food. Hence, development of new farming and planting system is very much essential to manage food crisis in the future. The present research aimed to examine an efficient technique for planting system *i.e.* hydroponic or soil less system of farming. The statistical experimental design approach was used to compare the growth between hydroponic system and the tap water system in the growth of *Cicer arietinum* and *Trigonella foenum-graecum*. The results showed that chickpea seeds after germination were grown up to 25 to 28cm in 16 days in the water however the same growth was recorded within 10 days in nutrient solution. Whereas, fenugreek seeds after germination were grown up to 3 to 4cm in the water after 8 days and up to 4 to 5cm in a week in the nutrient solution. Fast and better growth of seeds after germination was observed in the nutrient solution than the tap water.

Key words : Hydroponics, Leafy vegetables, *Cicer arietinum*, *Trigonella foenum-graecum*, Sustainable farming.

Introduction

The name hydroponics derived from Greek words 'hydro' for water and 'ponos' for labour (Beibel, 1960). It is the soilless culture of plants, but in the presence of artificial supporting medium (Bhattarai *et al.,* 2008; Sardare and Admane, 2013). It is asustainable development of food as a basic need of human beings by rational use of natural resources (Besthorn, 2013; Podmirseg, 2014). It provides the ability to reuse water and nutrients, control environmental conditions, higher yield and prevention of soil-borne diseases and insects (Molitor, 1989; Lommen, 2017). It was estimated that 700 million peoples used the vegetables grown in untreated or partially treated waste water, and the health risks for those involved in the production chains are questionable (Hamilton *et al.,* 2007; Jiménez and Asano, 2008). These available wastewaters may contain nutrients that favor the crop growth, but could possibly exceed the physiological demand to administer toxic effects, and might be subjected to bio-accumulative impacts throughout the food chains. These available wastewaters may contain nutrients that favor the crop growth, but could possibly exceed the physiological demand to administer toxic effects, and might be subjected to bio-accumulative impacts throughout the food chains (Gericke, 1940; Keraita *et al.,* 2008). The hydroponics helps to solve the problem of climate change and in the management of efficient utilization of natural resources as well as malnutrition. In India this system was introduced in the year 1946 by an English scientist, W. J. Shalto Douglas and written a book on hydroponics, entitled '*Hydroponics: The Bengal System*' (Douglas, 1975). Maeva Makendi proposed a hypothesis and stated 'if the hydroponic plants and plants grown in soil are given the same germinating

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and growing conditions, then the hydroponic plants will do well if not even better than the plants grown in soil'. The hypothesis was corroborated to the findings on soil-less and soil-based systems (Kazzaz and Kazzaz, 2017; Kumari *et al.,* 2018; Somerville *et al.,* 2018). The investigation was done on different plants for a month and hydroponic plants did germinate and grew faster than soil plants (Chow *et al.,* 2017; Montgomery, 2018). The NASA has done research on this system for its Controlled Ecological Life Support System, CELSS (Pandey *et al.,* 2009). As it does not required soil for plant growth, it may be helpful for the astronauts during their time in space to get their food. This helps both home kitchen gardeners and farmers to grow food in places where traditional soil system is not possible or cost-effective. The hydroponic system can provide 20–25% higher yields than a soil-based system.

Materials and Methods

At first the viable seeds of *Cicer arietinum* and *Trigonella foenum-graecum* were selected for experiment. The viability of seeds was checked by just soaking them in water and those float in the water were supposed to non-viable seeds and discarded. The next step was to prepare the nutrient media, the Hoagland solution after Hoagland and Arnon (1938). The seeds were placed in different trays and soaked them in two different solutions *i.e.* Hoagland solution and tap water. After the germination of seeds, these get transferred in baskets after Jensen and Collins (1985). On the day 1st, seeds were soaked. Next day that is on day 2nd, seeds were found to be swollen. On day 3rd, seeds were found to be sprouted. Sprouted seeds were then transferred in a strained basket kept over a plain basket filled with water/solution up to the lower surface of the strained one, so the sprouted seeds remain in contact with water/solution. The growth patterns of plants were noticed periodically for each experimental seeds in respective baskets. The differences in growth as plant length were measured and recorded. The plants were harvested after its full or optimum growth.

Results

It took one and half month to complete the entire experiment of plants growth in hydroponic system grown in tap water and nutrient solution. Comprehensive analyses were worked out to assess the effect of tap water and nutrient solution on the growth of the leafy vegetables.

Cicer arietinum (Fig. 1, Table 1)

Shooting

Seeds of chickpea were soaked in water and solution

Fig. 1: Profuse Rooting and shooting growth of *Cicer arietinum* seed on 10th day of hydroponics experiment in nutrient solution.

Table 1: Comparative accounts for the effect of tap water and nutrient solution in hydroponic system on the growth pattern of *Cicer arietinum* shoot and root system.

Days of experiment	Shoot system				Root system	
	Tap water		Nutrient solution		Tap water	Nutrient solution
	No. of Leaf	Length (cm)	No. of Leaf	Length (cm)	Length (cm)	Length (cm)
1	Nil	Nil	Nil	Nil	Nil	Nil
2	Nil	Nil	Nil	Nil	Nil	Nil
3	Nil	Nil	Nil	Nil	Nil	Nil
4	1	2	1	3-4	2	2
5	1	3-4	2	6-8	2	2
6	2-3	5-6	3-5	10-12	3	3
7	3-4	7-8	5-8	16-18	4	4
8	5-6	9-14	5-8	16-18	4	4
10	5-6	9-14	8-10	25-28	4-5	4-5
11	7-8	15-19	-	-	4-5	4-5
16	8-10	25-28	-	-	5	5-6

separately and observed for 25-30 days. The survival rate of seeds in water and solution was 28/30 and 30/30 respectively. On day 4th, growth of shoots 2cm in water and about 3-4cm in solution were observed. Rapid elongation of the shoots was seen on the next consecutive days. Maximum growth was observed on the day 16th, shoots up to 25-28cm in tap water, whereas on the 10th day shoots up to 25-28cm in nutrient solution.

Rooting

The initiation of root was observed from the day 3rd both in water as well as in solution. On the day 4th, growth of roots about 1-2cm in water and 2cm in solution were observed. Rapid elongations of the roots were seen on the next consecutive days. The maximum growth was observed on the day 16th, roots up to 5-6cm in water, whereas on the 10th day, roots up to 8-10cm in nutrient solution and roots were found to be very dense in solution than in the water.

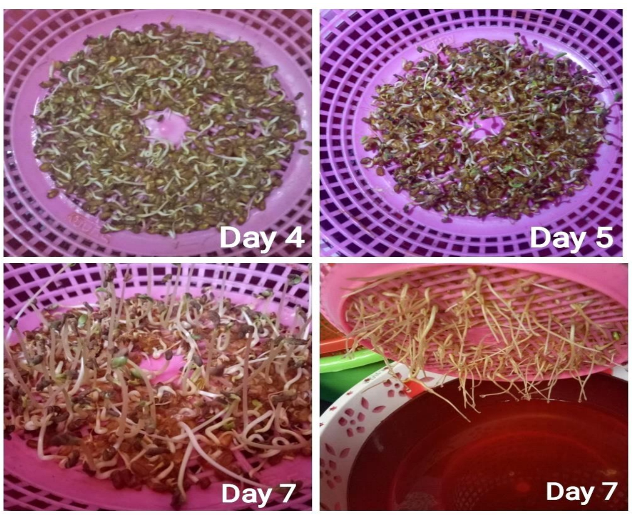

Fig. 2: Effect of nutrient solution in hydroponic system on the germination (4th day), shooting (5th and 7th day) and rooting (7th day) of *Trigonella foenum-graecum*.

***Trigonella foenum-graecum* (Fig. 2, Table 2)**

Shooting

Seeds of fenugreek were soaked in water and solution separately and observed for 7-10days. On the day 4th, growth of shoots about 2cm in water and about 3-4cm in solution were observed. The growth of shoots was observed on the next consecutive days. Elongation was observed on the day 8th, shoots up to 3-4cm in tap water, whereas on the 7th day, up to 3-4cm in nutrient solution. Fenugreek seeds were found not to be grown well due to sudden rise in the temperature and plantlets were damaged soon.

Rooting

On the day 4th, growth of roots about 1-2cm in water and 2cm in solution were observed. The elongation of roots was seen on the next consecutive days. Growth on day 8th day was up to 3cm in water whereas, up to 4cm in solution. Fenugreek seeds were found not to be grown well due to sudden rise in temperature and thus no further observations could be recorded as the plants damaged.

Discussion

The growth of the plants was measured for about 30 in chickpea and about 15 in fenugreek during experiment. The height of the plants and roots separately in water and in solution was measured. It was revealed that plants growing in solution grow faster than in the water. Gashgari *et al*., (2018) observed that hydroponic system has a better effect on the growth and development of cucumber. The difference in the rate of growth was observed in the height of the plants after germination of seeds (Ferguson *et al.,* 2014). We took chickpea and fenugreek seeds in water and solution (nutrient medium). The chickpea and fenugreek seeds after germination, transferred in water and solution to grow hydroponically. Observations told that there was a great difference in the height of plants;

Table 2: Comparative accounts for the effect of tap water and nutrient solution in hydroponic system on the growth pattern of *Trigonella foenum-graecum* shoot and root system.

Days of experiment	Shoot system				Root system	
	Tap water		Nutrient solution		Tap water	Nutrient solution
	No. of Leaf	Length (cm)	No. of Leaf	Length (cm)	Length (cm)	Length (cm)
1	Nil	Nil	Nil	Nil	Nil	Nil
2	Nil	Nil	Nil	Nil	Nil	Nil
3	1	2	1	2	1	1
4	1	2-3	1	2-3	1-2	2
5	2	3	2	3	2	2
6	2	3-4	2	3-4	2	2
7	2	3-4	2	4-5	3	3-4
8	2	3-4	2	4-5	3	4

and the growing time took by particular seeds in water and solution, both the observations were different. Alloush (2003), observed the effect of phosphorus on chickpea, root image analysis showed dense branching in low-P, resulting shorter but slender roots than those in high-P plants. Alloush and Sanders (1990) also studied the responses of chickpea (*Cicer arietinum*) to iron stress in hydroponics system.

All plants, in the tap water and in the nutrient solution, germinated and grew. However, since only in solution grown plants showed better results than in water grown plants. Fenugreek seeds were germinated well in both water and solution but did not showed the expected growth in further days after germination. This was due to the sudden rise in the temperature. As fenugreek was a winter crop, still authors tried to grow it in summer, but due to high temperature, plants did not showed significant growth and got damaged soon. Singh *et al*., (2019) observed that plants showed very good growth in Hoagland solution in comparison to tap water, and the temperature also play a significant role in the hydroponic culture. Thus the soil less solution based hydroponic system is much better than the tap water hydroponic system as the solution hydroponic system had a better effect as it made the plant grow faster (Ghamonde *et al.,* 2016). According to Shaileshwari *et al*., (2018) with the usage of hydroponics techniques, healthy plants can be grown by using the hydroponic trays carrying monitored values of magnesium, calcium and pH decreased day by day so that plants will get sufficient minerals to grow. According to Somen *et al*., (2019) hydroponics is easy to maintain minerals and to examine productivity that was tough in soil. The disease control system in hydroponics is also good. Thus hydroponics is suitable and beneficial for farmers in now-a-days.

Conclusions

In the present study of emerging hydroponic system, the seeds of *Cicer arietinum* and *Trigonella foenum-graecum* were grown in hydroponic culture. The results showed that hydroponic planting system had a better effect on plant growth, than tap water system. On the other hand, the planting system and seed type had no significant effect on the length of leaves and growth of plants. As it did not required soil for plant growth, it may be helpful for the astronauts during their time in space to get their food. This system may help both kitchen gardeners and farmers to grow food in places where traditional farming is not possible and cost-effective. The hydroponics system offers conservation of water, soil, air, energy and employment for the quality of life. The hydroponics can enhance the economy of both developing and developed countries by using of limited natural resources.

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