International Research Journal of Plant Science (ISSN: 2141-5447)
Vol. 14(1) pp. 01-06, January, 2023
DOI: http:/dx.doi.org/10.14303/irjps.2023.044
Available online @ https://www.interesjournals.org/plant-science.html

Research Article

Comparative Study on the Growth Performance of *Cicer arietinum* L. (Chickpea) in Hydroponic System and Soil

Rahul Kumar*

Department of Botany, Government Postgraduate College, Uttarakhand, India

E- mail: rahulkumar18.rk54@gmail.com

Abstract

Hydroponics is a technique of growing plants in water that consists of dissolved nutrients and growing media is used to support the plants in the medium. The field experiment was conducted in Bazpur from September to November in 2019 for the comparative study of *Cicer arietinum* L. in a hydroponic system with soil grown plants. The Nutrition Film Technique (NFT) of the hydroponic system was used in the present study. In NFT the roots get nutrition from the flowing nutrition solution in PVC pipe channels. Chickpea plants were selected for an experiment. The chickpea plants were raised in the hydroponic system and also in the soil for comparative study. Plant growth data was collected every week from both hydroponic and soil grown plants. Plant height, the diameter of the stem of plants, leaf size, and the number of leaves were observed and analyzed. Data were statistically analyzed and after data analysis in the present study, we can conclude that the growth of chickpea plants in the hydroponic system is more than the soil system. Flowering and fruiting are also seen in the hydroponic system in a short period. We can use the hydroponic system for various crops to get better growth and yield. It is also feasible under Indian climatic conditions. Hydroponics is a Greek word that is formed from two words "Hydro" and "ponos". Where "Hydro" means water and "ponos" means working. Hydroponics is a method in which we grow plants without soil. We use minerals nutrient solutions in water solvents in this system. In this experiment, only one plant type is considered. However, the experiment can be done using different types of plant species.

Keywords: Hydroponic culture, Nutrition film technique, *Cicer arietinum,* Chickpea plants

INTRODUCTION

We can define hydroponics as follows. A technique of growing plants without soil in water containing dissolved nutrients. In this technique plants, roots are exposed to the nutritious water and some roots are physically supported by the media like clay ball, gravels, rice husk, coco peat, and perlite, etc. This supporting media will also support the plant's growth. Hydroponics is water-based cultivation (Ghazvini et al., 2007).

NFT: In the NFT system plants grown in gullies are also known as channels. Nutrition solution is pumped throughout the reservoir in the channels as shown in the figure. The plant's roots are kept moisturized which receives the nutrition from the thin film of the nutrition solution. The roots at the bottom are exposed into the solution while the top parts of roots emerge in the supporting media. NFT was developed in the 1920s in China by Dr. Alan Zhang. The basic principle of the nutrient film technique is to keep the thin layer of nutrition solution, constant flow through the tray of plant roots (Peres et al., 2007).

Received: 19-May-2021, Manuscript No. IRJPS-21-31814; **Editor assigned:** 24-May-2021, PreQC No. IRJPS-21-31814 (PQ); **Reviewed:** 07- Jun-2021, QC No. IRJPS-21-31814; **Revised:** 02-Jan-2023, Manuscript No. IRJPS-21-31814 (R); **Published:** 30-Jan-2023

Citation: Kumar R (2023). Comparative Study on the Growth Performance of *Cicer arietinum* L. (Chickpea) in Hydroponic System and Soil. IRJPS. 14: 044.

Since the early twenties century, It has the production of herbs. In NFT system the water film solution moves downward and is collected in the gutter (Martins et al., 2009). This gutter transports the water back to the reservoir. NFT system can promote the use of greenhouse areas with better quality and quantity. Due to the good environment growth rate of plants increase and the life cycle of plants becomes short (Morgan et al., 2012).

Nutrient solution: The nutrient solution is an aqueous solution used for a hydroponic system in which organic ion soluble salts of essential elements are dissolved (Poole et al., 1992). Essential elements play an important physiological role and their absence prevents the complete life cycle of plants. Currently, 17 elements are considered essential elements for plants. Some of these are magnesium, sulfur, iron, copper, zinc, manganese, molybdenum, boron, chlorine, nickel (Santos et al., 2010).

Growing media: In hydroponics the growing media is used as soil to support the plants in the nutrient solution. Growing media absorbed the nutrient solution for plants (Ullah et al., 2020). In soil, the plant's roots need to work hard for reaching nutrition but in hydroponics, the plant's roots do not need to work hard. Growing media are that substrate that provides the mechanical support to plats and moisturized their roots. The growing mediums we can use in hydroponics are as follows (Singh et al., 2022).

Rockwool, coco fiber, cocopeat, perlite, vermiculite medium cocopeat, rice husk, clay ball, growing stone, sand, gravels, and wood fibers. The soil less media such as perlite and zeolite are better than the soil media for growing the plants. He used zeolite and perlite and noticed that the plants grow two times faster with the higher yield. This was due to high oxygen level, optimum pH, perlite and zeolite.

MATERIALS AND METHODS

The study area selected for the present investigation is located in Bazpur. Bazpur is located in the U.S.Nagar which is the Tarai region of the Kumaun division in Uttarakhand. U.S.Nagar is a district of Uttarakhand state in northern India. The climate of the U.S.Nagar is warm and temperate. The average annual temperature of U.S.Nagar is 24.3°C. The hydroponic system using NFT (Nutrient Film Technique) is established under polyhouse for the comparative study with soil grown chickpea plants. The soil less culture medium cocopeat was used for the germination of chickpeas seeds in net pots. The seeds are germinated within the five days in the last week of September 2019. PVC pipes of 4-inch diameter were used in the formation of the hydroponic system, which is placed on the triangle-shaped iron frame **(Figure 1)**.

Figure 1. Design of Nutrition Film Technique (NFT) hydroponic system.

Cocopeat was used as a growing medium in the hydroponics system. Cocopeat is a soil less growing media used in the hydroponic system to obtain the best result. It is spongy and the byproduct of coconut fibers and. A stand was prepared for supporting PVC pipes which were triangle shaped in structure. The length of each triangle shaped stand is 20 ft. There were 4 stands used in the NFT system (Hartung et al., 2000).

PVC pipes with 20 feet in length and 4 inches in diameter were used. There was a total of 11 pipes used for NFT in which 26 holes on each were created with the help of a drill machine. The size of net pots was 3 inch in length and 3 inch in diameter. There is a total of 26 x 11=286 net pots are used in the NFT system. Net pots are filled with supporting and seeds were grown on them (Singh et al., 2020).

One tank of capacity 10 L was used which contain the nutrient solution. In which water pump emerged. The nutrient solution is recirculated in the tank with the help of a water pump. The submersed low capacity water pump is placed in the tank for circulating the water in NFT. The frequency of the pump was 50 H/z and the power 250 Walt.

There is one hedder placed on the top of the tank. This supplies the water into the channels. Hedder has a diameter of 6 inches, containing 2 end caps that have a diameter of 6 inches. The length of hedder was 2 ft. End caps are used for closing both the end of PVC pipes and channels to prevent leakage from PVC pipes (Shahzad et al., 2014).

There was 2 end cap fixed at both the ends of the pipes, a total of 22 end caps were used for 11 pipes channels. One out of 2 end caps has a joint hook that circulates the water into a reservoir. In the NFT hydroponic system nutrient solution is made by the water-soluble NPK fertilizer (Wouterlood et al., 2004).

NPK stands for Nitrogen, Phosphorus and Potassium these are three important macronutrients so NPK is used as a complex of all three major primary macronutrients in the form of nutrient solution. Chickpea (*Cicer arietinum* L.) was selected for study work. The chickpea has belongs to the family *Fabaceae* which is also known as bengal gram or chana. It is a type of pulse and an annual legume herb. Chickpea seeds are rich in protein. The bushy herb plants contain feathery pinnately compound leaves. It has white, reddish, and bluish and small sized flowers. One or two yellow brown or dark green beans are produced in each pod. After plantation and seed germination, the plants were made to grow under observation. The data was collected every week till the chickpea plants give their fruit (Chen et al., 2017).

RESULT AND DISCUSSION

The result was obtained from the observation. This data was collected one week after transplanting the plants **(Table 1)**.

Table 1. Observation measurement of plants height and stem diameter in hydroponic and soil grown plants.

Duration	Plants height		Stem diameter	
	In Hydroponic	In Soil	In Hydroponics	In Soil
Week 1	3 cm	2.5 cm	0.9 mm	0.7 mm
Week 2	6 cm	5 cm	1.4 mm	1.0 mm
Week 3	13 cm	10 cm	2.1 mm	1.4 mm
Week 4	19 cm	14 cm	2.8 mm	1.7 mm
Week 5	26 cm	19 cm	3.2 mm	2.0 mm
Week 6	33 cm	25 cm	3.7 mm	2.3 mm
Week 7	37 cm	27 cm	4.1 mm	2.8 mm
Week 8	43 cm	30 cm	4.4 mm	3.0 mm

Plant height: From the observation table, we can say that the rate of growth of plants in a hydroponic system is remarkable higher than soil grown plants. The plants grow in the hydroponic system were more in height than the plants grown in soil. This comparison can be seen in the chart given below **(Figure 2)**.

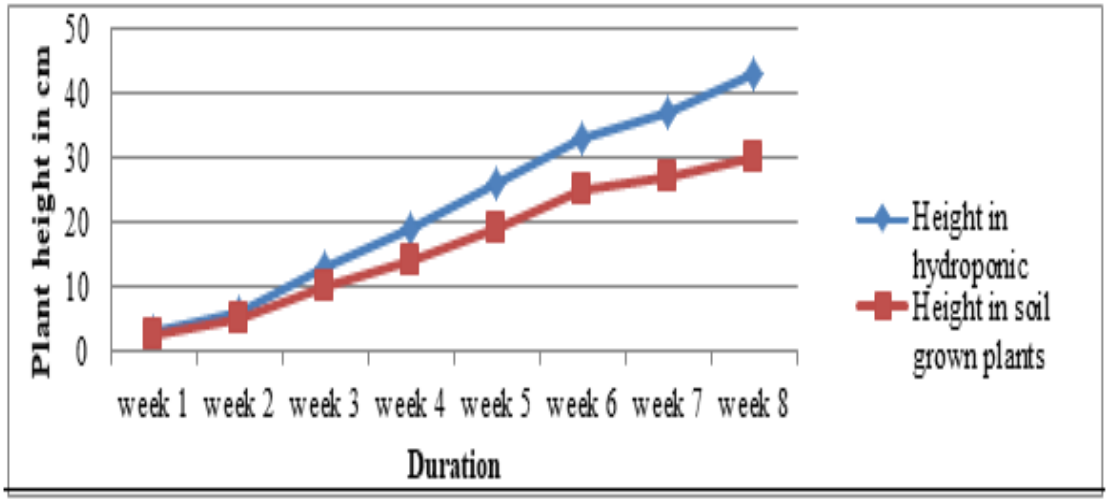

Figure 2. Plants height comparison graphical representation.

Citation: Kumar R (2023). Comparative Study on the Growth Performance of *Cicer arietinum* L. (Chickpea) in Hydroponic System and Soil. IRJPS. 14: 044.

Stem diameter: The observation shows the variation in diameter of stems between the plants grown in the hydroponic system and those grown in soil. The plants grown in the hydroponic system show better stem growth, thus the diameter of plants was more than those plants grown in the soil the diameter of the stem in both conditions can be compared using a chart given below **(Table 2 and Figures 3-6)**.

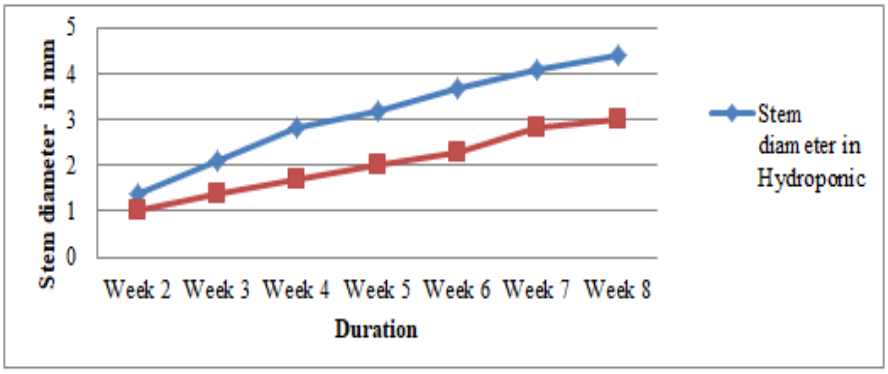

Figure 3. Stem diameter comparison and graphical representation.

Table 2. Observation measurements of leaf parameters in hydroponic and soil grown plants.

Duration	Length of leaf		Breadth of leaf		Leaf number per plant	
	In Hydroponic	In Soil	In Hydroponic	In Soil	In Hydroponic	In Soil
Week 1	1.3 cm	1.1 cm	0.8 cm	0.5 cm	4 leaves	3 leaves
Week 2	2.7 cm	1.9 cm	0.9 cm	0.8 cm	7 leaves	4 leaves
Week 3	3.3 cm	2.4 cm	1.4 c,	1.0 cm	9 leaves	6 leaves
Week 4	4.3 cm	2.9 cm	1.7 cm	1.3 cm	12 leaves	8 leaves
Week 5	5.1 cm	3.5 cm	1.8 cm	1.4 cm	15 leaves	10 leaves
Week 6	5.7 cm	3.9 cm	1.9 cm	1.7 cm	17 leaves	13 leaves
Week 7	6.2 cm	4.3 cm	2.1 cm	1.8 cm	19 leaves	15 leaves
Week 8	7.0 cm	4.5 cm	2.5 cm	2.0 cm	21 leaves	17 leaves

Leaf size and number: The leaf size of plants grown in the hydroponics system is very larger than the leaf size of plants from the soil. In the hydroponic system, the plants have more leaves than those plants grown in the soil it indicates the greater yielding in the hydroponics grown plants. The graphical comparison of both conditions in plants are given below (Imtiaz et al., 2015).

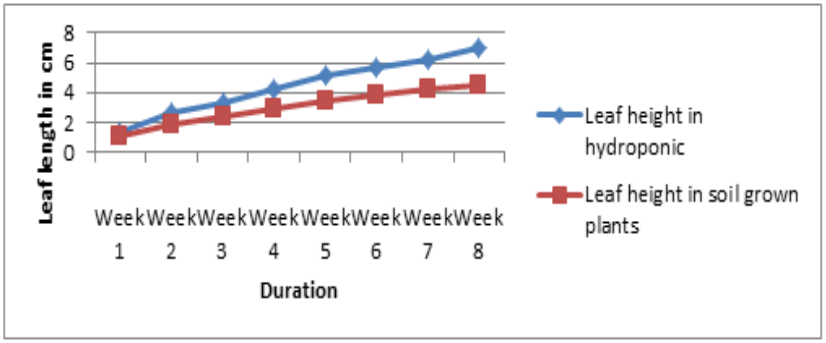

Figure 4. Leaf length comparison and graphical representation.

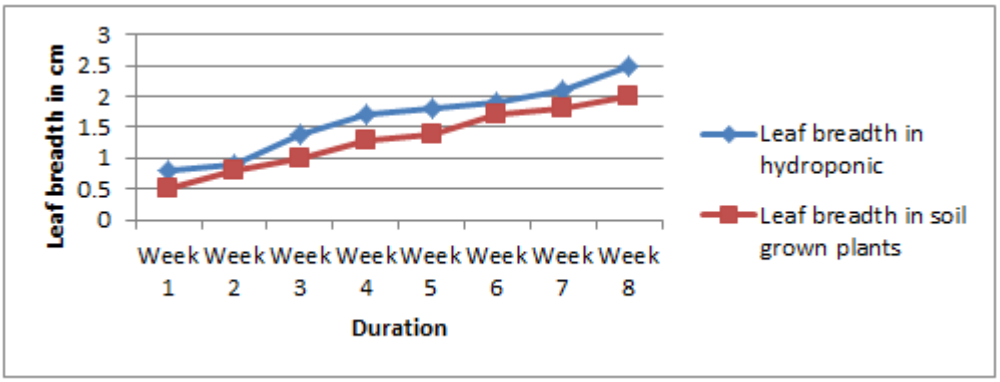

Figure 5. Leaf breadth comparison and graphical representation.

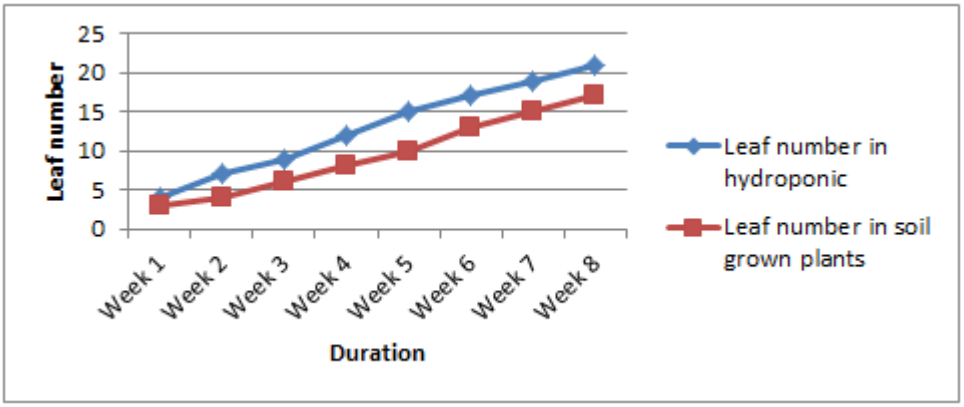

Figure 6. Leaf number comparison and graphical representation.

Cicer arietinum L. was sown in both the hydroponic system and in the soil. All the parameters of plants show that on comparing the hydroponic system with traditional plants growing method we can say that plants grown in a hydroponic system are taller (Upadhyay et al., 2021). They showed better and rapid growth in the hydroponics system. A higher growth rate was reported in a hydroponic system. The plants in the hydroponic system get nutrition from the flowing water easily their roots do not have to reach farther (Hamaoui et al., 2001). Thus we can say that the hydroponic system can be used to produce good quality plants in a shorter period. This will give high quality yield and highly effective products.

CONCLUSION

High demand for food production is needed in the world day by day as the population is growing fast. The traditional farming method of using a soil system will not cover the world's growing demand for food. Thus the development of a new technique (hydroponic system) is required. This study aimed to examine the growth rate in the hydroponic system and the soil. The statistical experimental design approach was used to analyze the comparison between the traditional soil system and the hydroponic system by planting the same species of chickpea plants. After analyzing the data and results we can conclude that the hydroponic system is better than the traditional soil system. The final result clearly shows that the hydroponic planting system has a better effect than the traditional system. Plants grow faster in the hydroponic system this effect is shown on the plant's height, stem diameter, leaf size as well as leaf number which indicates the better yield. Chickpea plants which are grown in soil flowering in 8^{th} week on the other hand plants which are grown in hydroponics system started fruiting in just 8^{th} week. For future work this experiment can be done on the large scale this will help to fulfill the demand of today's futures market. The period of the experiment should be expanded as new changes may appear after a while. An important note to consider is the type of plants. In this experiment, only one plant type is considered. However, the experiment can be done using different types of plant species.

Citation: Kumar R (2023). Comparative Study on the Growth Performance of *Cicer arietinum* L. (Chickpea) in Hydroponic System and Soil. IRJPS. 14: 044.

REFERENCES

Ghazvini RF, Payvast G, Azarian H (2007). Effect of clinoptiloliticzeolite and perlite mixtures on the yield and quality of strawberry in soil less culture. Int J Agric Biol. 9: 885-888. [Google Scholar]

Peres MR, Boaro CSF, Lopes JLW, Guimarães VF (2007). Growth of lettuce seedlings in different substrates. Biotemas. 20: 19-25. [Crossref] [Google Scholar]

Martins CM, de Medeiros JF, Lopes WAR, Braga DF, de Amorim LB (2009). Curve of absorption of nutrients in hydroponic lettuce. Caatinga. 22: 123-128. [Google Scholar]

Morgan L (2012). Hydroponic salad crop production. Suntec. 89-97. [Google Scholar]

Poole RT, Conover CA (1992) Fertilizer levels and medium affect foliage plant growth in an ebb and flow irrigation system. J Env Horticul. 10: 81-86. [Crossref] [Google Scholar]

Santos AN, Soares TM, Silva ÊF, Silva DJ, Montenegro AA (2010). Hydroponic lettuce production with brackish groundwater and desalination waste in Ibimirim, PE, Brazil. Revista Brasileira de Engenharia Agrícola e Ambiental. 14: 961-969. [Crossref] [Google Scholar]

Ullah S, Khan J, Hayat K, Abdelfattah Elateeq A, Salam U, et al. (2020). Comparative study of growth, cadmium accumulation and tolerance of three chickpea (*Cicer arietinum* L.) cultivars. Plants. 9: 310. [Crossref] [Google Scholar] [PubMed]

Singh D, Singh CK, Singh D, Sarkar SK, Prasad SK, et al. (2022). Glycine betaine modulates chromium (VI)-induced morpho-physiological and biochemical responses to mitigate chromium toxicity in chickpea (*Cicer arietinum* L.) cultivars. Sci Rep. 12: 8005. [Crossref] [Google Scholar] [PubMed]

Hartung W, Leport L, Ratcliffe RG, Sauter A, Duda R, et al. (2000). Abscisic acid concentration, root pH and anatomy do not explain growth differences of chickpea (*Cicer arietinum* L.) and lupin (*Lupinus angustifolius* L.) on acid and alkaline soils. Plant Soil. 240: 191-199. [Crossref] [Google Scholar]

Singh D, Sharma NL, Singh CK, Sarkar SK, Singh I, et al. (2020). Effect of chromium (VI) toxicity on morpho-physiological characteristics, yield, and yield components of two chickpea (*Cicer arietinum* L.) varieties. PloS One. 15: e0243032. [Crossref] [Google Scholar] [PubMed]

Shahzad SM, Khalid A, Arif MS, Riaz M, Ashraf M, et al. (2014). Co-inoculation integrated with P-enriched compost improved nodulation and growth of Chickpea (*Cicer arietinum* L.) under irrigated and rainfed farming systems. Biology Fertility Soils. 50: 1-12. [Crossref] [Google Scholar]

Wouterlood, M., Cawthray, G. R., Scanlon, T. T., Lambers H, Veneklaas EJ (2004) Carboxylate concentrations in the rhizosphere of lateral roots of chickpea (*Cicer arietinum*) increase during plant development, but are not correlated with phosphorus status of soil or plants. New Phytol. 162: 745-753. [Crossref] [Google Scholar] [PubMed]

Chen Y, Ghanem ME, Siddique KH (2017). Characterising root trait variability in chickpea (*Cicer arietinum* L.) germplasm. J Exp Botany. 68: 1987-1999. [Crossref] [Google Scholar] [PubMed]

Imtiaz M, Tu S, Xie Z, Han D, Ashraf M, et al. (2015). Growth, V uptake, and antioxidant enzymes responses of chickpea (*Cicer arietinum* L.) genotypes under vanadium stress. Plant Soil. 390: 17-27. [Crossref] [Google Scholar]

Upadhyay SK, Ahmad M, Srivastava AK, Abhilash PC, Sharma B (2021). Optimization of eco-friendly novel amendments for sustainable utilization of fly ash based on growth performance, hormones, antioxidant, and heavy metal translocation in chickpea (*Cicer arietinum* L.) plant. Chemosphere. 267: 129216. [Crossref] [Google Scholar] [PubMed]

Hamaoui B, Abbadi J, Burdman S, Rashid A, Sarig S, et al. (2001). Effects of inoculation with *Azospirillum brasilense* on chickpeas (*Cicer arietinum*) and faba beans (*Vicia faba*) under different growth conditions. Agronomie. 21: 553-560. [Crossref] [Google Scholar]