

Turnip (*Brassica rapa*) cultivation under modern farming system

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Increasing rapid growth rate of urban population coupled with increasing greenhouse effect, global warming and decreasing per capita land availability vis-a-vis unpredictable weather condition, and increasing demand of organic food has brought us towards Hydroponics cultivation. This article details the cultivation of root vegetable (Turnip) under hydroponics and soilless growing media. Hydroponics grown crop contains higher (154 g) yield of edible root/plant, yield of fresh leaves/plant (115 g), and higher (45.56 mg/100g) chlorophyll content due to more uptake of nutrients through plant root. Higher production and productivity under soilless and hydroponics cultivation is due to well availability of nutrients as compared to conventional farming system.

Keywords: Hydroponics, Intensive farming, Production, Soilless, Turnip

There is an urgent need to reduce carbon emissions, increase food production system for achieving sustainable goals besides protecting the earth from greenhouse effect by keeping the earth temperature below 1.5°C. According to UN report, due to rapidly increasing urbanization, 70% of the world's population will become urban by 2050 as compared to 49% today which may increase carbon emissions by 75%. It is expected that the rapid growth rate of population, will require additional increase in food production to avoid food crisis in upcoming years. So, increasing the food production by using innovative agriculture production technology like hydroponics, soilless cultivation, aeroponics, aquaponics etc. is essential. Increasing scarcity of water availability, increased levels of residual toxicity in vegetables crops and rapid growth rate of urban population have attracted the global attention towards the use of intensive cropping systems. Challenges faced during COVID-19 showed that the availability of periodic labour is critical under conventional farming. There is

an increase in demand of food and tendency of people towards organic produce, just like the need for more automated and intensive farming for higher production with better quality. According to FAO (2023), urbanization is rapidly on rise, changing pattern of population

agglomerations across a rural-urban continuum with impacts socio-economic conditions, bring us towards increasing the agrifood systems, with better implications for the availability and affordability of healthy diets, and in turn for food security and nutrition.



Performance of turnip (*Brassica rapa*) crop under soilless vertical farming using small size plant grow pot

Hydroponics is a method of growing the crops without soil with the help of nutrient solution. Globally, hydroponic farming is an emerging technology because of proper utilization of natural resources. It plays a vital role in areas where soil and water are limiting factor for cultivation. Advantages of hydroponic is that it requires small space with better provision for vertical space utilization and higher nutrient use efficiency and more water saving as compared to conventional farming. Hydroponics technology not only offers vertical utilization but also maintains quality and increases productivity of vegetable crop. It is worth saying that such farming practices are considered as eco-friendly due to their minimal use of pesticides, which results in no harmful effects on the environment as well as human health. Root crop is an important vegetable crop for human diet. These crops are rich source of vitamins. Among root vegetables, turnip is an important root vegetable which grown as a winter season vegetable. Turnip is mainly grown for its enlarged root. The fresh roots are used in salad and consumed as cooked vegetable. The young leaves are rich source of ascorbic acid, iron and vitamin A. The cultivation of root vegetable crop under soilless and hydroponics is challenging. Thus, the cultivation of Turnip crop under Hydroponics was attempted.

Advantages of Hydroponics cultivation

This technology has the following advantages as compared to conventional farming:



Uniform growth of Turnip (*Brassica rapa*) crop under Hydroponics (NFT) culture

- Hydroponics cultivation is also considered under organic farming due to zero use of insecticide, pesticides and chemical fertilizers.
- More water saving takes place under soilless culture as compared to conventional farming where more utilization of water takes place.
- Soilless cultivation can be easily practiced as kitchen gardening, roof farming and indoor cultivation.
- Soilless technology also suitable at boarder area which can play a vital role for Defence purpose.
- Higher production and productivity can be achieved under soilless cultivation due to more utilization of vertical space and protection from soilborne diseases.
- Hydroponics cultivation is less labour intensive due to more intercultural operations required under conventional farming such as weeding, hoeing.
- Hydroponics cultivation is eco-friendly without impact on environment.
- Hydroponics farming is based on the principle application of input such as 'Right Time, Right Manner and Right Quantity' which play a vital role in Precision Agriculture.

Factors affecting Hydroponics faming

The followings factors affect hydroponics

- **Soilless media:** Soilless media is the main component for raising healthy nursery. To ensure that media is free from harmful

microorganism, the media is properly fumigated with the help of Methyl bromide and proper aeration is necessary in soilless media for healthy crop growth.

- **Water:** It is the main component for hydroponics farming which is rich in salt. The saline water is not beneficial for crop grown under hydroponics. Rain water is most beneficial for hydroponics farming and it can be easily stored by using rain water harvesting. In hilly areas, due to more rainfall, rain water harvesting can be easily done. The electrical conductivity (EC) of water for hydroponic should be between 1.5- 2.5 dS/m and pH 6.5- 7.0.
- **Nutrient solution:** The recommend dose of all nutrients should be properly supplied. The nutrients solution should be supplied weekly or upon appearance of specific nutrient deficiency symptoms.
- **Oxygen:** For growing the crop under open field condition, there is no need for oxygen application but in hydroponics techniques, the artificial supply of oxygen is necessary in nutrient solution of under root zone. The improper level of oxygen may effect root growth and it may lead to root spoilage. The oxygen level of nutrients solution should be always between 9-18 ppm.
- **Temperature:** Temperature is the main factor in hydroponics farming. In conventional farming, sudden rise in temperature can cause fruit dropping (in early stage), flowering as well as increasing temperature in nutrients solution will enhance oxygen level degradation.



An overview of Hydroponically (NFT) grown fresh edible root after harvesting

Hydroponics culture

An experiment was conducted. During the study period, maximum and minimum temperature of the field and low-cost shade net was 28-34°C and 16-18°C respectively. Turnip var. Golden ball was sown in hydroponics model during October – January 2020 at DIBER, DRDO,

Haldwani, Nainital (Uttarakhand). Root vegetable seed was grown direct in the white colour UV stabilized bucket, vertical net pot and two-week-old seedling was transplanted in hydroponic during the month of October 2020. Hydroponic system used for growing the crop was designed and installed in low-cost polyhouse, which can accommodate 20-40 plants/unit. The unit is made of PVC pipe of 4-inch diameter. Six pipes of equal length were fixed on the frame and provision of 10 holes was made on each to accommodate 10 plants. Nutrient solution supplied to grow the plants in hydroponic system carried all essential nutrient with pH ranging from 6.5 to 7.5 with conductivity (EC) 1600 $\pm$ 100 ppm.

Soilless cultivation system used for the growing the crop was white colour UV stabilized buckets and vertical net pot filled with mixture of coco peat and vermiculite and partite ratio (3:1:1). and nutrient solution supplied to grow the plants in soilless system carried all essential nutrient with pH ranging from 6.5 to 7.5 and electrical conductivity (EC) 1800 $\pm$ 100 ppm. Harvesting was done 30 to 35 days after sowing.

Variety characteristics: The root is perfectly globe-shaped, medium size and smooth. It is bright creamy skin. The top is small erect and with cut leaves.

Nutrient solution for Hydroponics farming

The nutrient solution carried all essential macro- and micro-nutrient. Primary nutrients (C, H, O) were absorbed by plant through atmosphere. N, P, K, Ca, Mg, S are required by plant in large amount.



Performance of turnip crop under soilless media using UV stabilized white bucket

Nitrogen is necessary for plant growth and development; Mg is the main constituent for plant photosynthesis. K play important role to provide disease resistance to plant. Ca plays a vital role during fruit formation; P is beneficial for energy transformation during ADP to ATP formation. The hydroponics solution consists of all essential (macro and micro) nutrients.

Nutrients solution developed by DIBER (DRDO)

Macro-nutrients	Quantity
Calcium nitrate	120 g/100 L water
Potassium dihydrogen phosphate	20 g/100 L water
Potassium nitrate	80 g/100 L water
Magnesium sulphate	50 g/100 L water
Micro-nutrients	Quantity
Boron	30 g/100 L water
Manganese	20 g/100 L water
Zinc	20.3 g/100 L water
Copper	2.2 g/100 L water
Molybdenum	1.5 g/100 L water

Iron solution preparation: Weigh chelating agent EDTA (66.6 g/2 lit.) and dissolve in 600 mL distilled water. Add 8 g NaOH (Pellets) dissolved in 200 ml of water and warm up to 72°C. Add 50 g FeSO₄ dissolved in 600 mL distilled water and add 1 N H₂SO₄ (10 mL/2 lit) and warm up to 75-80°C, then mix both the solution and expose to aeration overnight to get ready-to-use (1 mg/lit) iron solution.



Nutrients concentration in hydroponics solution

Essential elements	Concentration (ppm)
Nitrogen	100-250
Phosphorus	30-50
Potassium	100-300
Calcium	50-100
Magnesium	30-70
Sulphur	50-70
Iron	1-5
Copper, Manganese, Zinc, Boron	< 0.2

Economic benefit of Hydroponics farming: The higher production and productivity under hydroponics farming is gaining more popularity and play a vital role for increasing farmers income. Being a modern and emerging technology for local investors, farmers in urban areas can promote self-employment and turn into a profitable business with community cooperation under controlled environment condition. Farmers can achieve higher economic benefit by using hydroponics and soilless culture as compared to conventional farming. It is challenging to cultivate the root crop under hydroponics. However, we successfully cultivated root crop (turnip) under different soilless media. Hydroponics farming increases the production and productivity with better quality due to well availability of nutrients and protection from soil borne diseases as compared to conventional farming system.

SUMMARY

The root vegetable can be successfully cultivated under Hydroponics cultivation. It may be beneficial for the farmers which are facing scarcity of water availability, land shortage problem. It is also beneficial for the people which are interested in indoor farming. More efforts are required for increasing the production and productivity of root crops under hydroponics technology.

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