Sultanate of Oman

Ministry of Education

Dhaklyah general directorate of Education

Um Hani School (8-12)

Study of the reality of using hydroponics and the use effect of an innovative nutrient solution of reed on plant growth in the hydroponic system

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Abstract :

The research aims to study the reality of using hydroponics with respect to climate change, and the effect of an innovative nutrient solution from reed on plant growth in the hydroponics system. This was done by answering the following questions:

1. What is the reality of using hydroponics in our society?

2. How can we create a nutritious solution for hydroponic system from reed?

3. What is the effect of using the innovative nutrient solution from reed on plant growth in the hydroponic system?

A questionnaire was developed and published, and the research was applied in the school's hydroponics system, where the activities of the water protocol (conductivity, salinity, and acidity) were applied before and after adding the nutrient solution from the reed. In addition, the ground

cover protocol for cultivated plants was applied and the growth rate was measured weekly.

The results of the research indicated that the community members had less than average awareness of hydroponics (48.2%), and the scarcity of their use of hydroponic systems, whether in their homes or farms (12.8%). The researchers succeeded in inventing the nutrient solution from the reed and adding it to the hydroponic system, which resulted in better growth rates in tomato plants (4.25 cm within two weeks) compared to using regular nutrients from the market (3.06 cm within two weeks). Thus, the researchers recommend the need to spread awareness about hydroponics, and the possibility of exploiting the reed and using it in nutrient solutions for hydroponic systems.

Key terms:

Hydroponics:

Cultivation of plants without using soil, by placing them directly in the water, and adding nutrients. (Fawzi, 2021)

Rogue plant (Phragmites australis): A genus of perennial herbaceous plant, belonging to the Grassy family, and includes two or three species, the most important of which is the giant jungle. Wikipedia from https://ar.wikipedia.org/wiki/ Jungle plant

Research questions:

The current study sought to answer the following research questions:

1. What is the reality of using hydroponics in our society?

2. How can we create a nutritious solution for hydroponic system from rogue plant (reed)?

3. What is the effect of using the innovative nutrient solution from rogue plant (reed) on plant growth in the hydroponic system?

Introduction and the literature review:

The "FAO" defines climate-smart agriculture as an approach to preparing the actions necessary to transform agricultural systems to support food security in the light of climate change, seeking to achieve three main goals. These goals are increasing productivity sustainably, adapting to and resilient to climate change, and reducing greenhouse gas emissions produced by farming practices (Urban, 2021). This is what hydroponic technology can achieve.

Hydroponics:

The population of the Earth will reach more than 9 billion people in 2050, and this huge number of people needs innovative solutions in order to secure food production much more efficiently than it is now. One of the new innovative ways is to use hydroponics technology as one of the engineering solutions to confront the changing climate.

Scientists and researchers who participated in the "GreenTech 2021" conference - held in the Dutch city of Amsterdam at the end of September agreed that "the future is for hydroponics."

Veronique Savulkul, director of global crop sales at BASF, said that the crops produced by her foundation are now able to feed 500 million people in the world, stressing that she has no doubts that the future is very bright for hydroponics, That is as mentioned by *Hortidaily* platform recently.

Hydroponics is a modern method of cultivation in which plants do not grow in the soil, rather they are directly grown in water with mineral components outside the soil.

This technology has many benefits; perhaps the most important of them is the significant increase in production compared to traditional agricultural methods. With this technology, we can grow more seeds that grow faster in water than they do in soil. Another benefit is that hydroponic plants have fewer problems with fungi, insects and diseases, so they are generally healthier than conventional crop plants. In addition to the decrease in the amount of heavy metals or pesticides that accumulate in the tissues of plants grown in the soil.

A major benefit of hydroponics is that there is no need for crop rotation as we can grow the same type of plant for many years and with the same productive efficiency.

Another advantage is to get rid of seasonal production and that is impossible to achieve by traditional methods. For example, we can pick strawberries or melons in January in winter when the snow is outside. Perhaps one of the most important features of this agricultural technology is - contrary to what is expected - that it requires less water than

traditional soil agriculture. This is because the water is recycled in a closed cycle and used many times through which it is condensed and delivered again to the cultivated plants.

If we look at hydroponics only from an environmental point of view, we can see that the impact of this method on the environment is not completely clear. On the one hand, this method of agriculture uses less water and does not cause soil erosion or consumption. This technique also reduces the use of fossil fuels because agricultural machinery is not used in cultivating, seeding and transporting. On the other hand, pesticides are rarely used to control weeds. All these factors have a positive impact on the environment and human health.

Hydroponics is a new technology that can help humanity fight hunger and provide more food as we can now buy hydroponics devices to use in our homes. There is no longer a need to buy expensive agricultural land, or consume large amounts of water as is the case in irrigated agriculture, or wait for rain as is the case with most farmers in the world who depend on water rains to produce their crops.

We can now grow much larger quantities of crops in our homes through this advanced technology in agriculture without the need for soil, rain or sunlight. We also can choose the vegetable & fruit varieties we want to produce regardless of the cycle of seasons. As technology advances, hydroponics could be one of the most efficient and sustainable ways to grow fruits and vegetables in the future. (Snagelh, 2021)

- Rough plant (reeds)

The rogue plant, reed, or jungle spreads in most lakes, on the shores of canals, banks, and rivers. The reed plant is known by other names, including sedge, jungle or reed, and its scientific name is

Phragmites australis. It is known in English as Common Reed. It is a perennial plant (meaning its life cycle extends to more than two years). It has rhizome ground stems extending from 40-100 cm and perhaps up to 200 cm inside the soil and its length is usually from 2 to 4 meters. It is said that its original home is America, and it is a universal plant as it spreads in all cold regions and humid tropical deserts such as Africa, some countries of Asia, Mexico, Chile, Argentina and some European countries. It grows in areas where there are sewage pools or in low areas that rainwater gather in those areas with a high ground water level.

This plant gives flowers in the form of spikes that produce a big number of seeds, and multiply either by seed or by rhizome stem. The wind plays a vital role in its spread, as the seeds are moved from one place to another by the wind, and then these seeds germinate when they fall in a high-humidity agricultural environment.

One of the most important environmental uses of rough or jungle is its use in sewage treatment and purification in many European countries such as Britain, Denmark, and Egypt. (Al-Haysheh, 2005)

It is worth mentioning that a previous research within the GLOBE program presented by the school (Um Hani) , carried out by (Al-Nadabia et al., 2018), indicated the effectiveness of using rough (reed) in plant fertilization, as tomato plants fertilized with rough (reed) recorded faster growth rates than those fertilized with regular fertilizer.

If the rough plant (reed) or jungle has the ability to absorb organic substances from the soil and wastewater, there is no doubt that it will contain good elements through which this plant can be exploited.

The idea of this research came in light of the changing climate in an effort to study the reality of people's use of hydroponics engineering. In addition, it studies the possibility of creating a nutrient solution from the rough plant (reed) and using it in the hydroponics system instead of the nutrients available in the markets.

Research methodology: research plan

Setting a research time plan

Table (1) Timeline of the research plan

Month	Work plan
November 2021	Formulation of the research problem and identification of tools
December2021 / January 2022	Visit study sites and collect and analyze data
February 2022	Draw conclusions, write research
March 2022	Submit research to the local committee, Translating the research into English and participating in the international virtual exhibition

- Distribution of work roles to the research team represented in preparing tools and field application.

Table (2) Distribution of work roles

Anfal and Rahaf	Application of the water protocol to samples
Rahaf	Application of the ground cover protocol, observation and measurement of plant growth
Anfal	Photographing the search steps
Anfal and Rahaf	Data analysis and research writing under the supervision of a teacher

- Identifying, reviewing and documenting some sources of information related to the topic of research.
- Coordinating a visit for a community member interested in different farming techniques, including hydroponics.
- Publishing a questionnaire to study the reality of people's use of aquaculture in Omani society.
- Choosing and defining the location of the study in preparation for the start of data collection. (school environment).
- Determining the appropriate protocols for collecting research data, which were mainly represented in the water protocol and the land cover protocol.
- Determining the appropriate devices and tools to implement the research plan (conductivity and salinity meter, pH meter, GPS, cups, water, paper, pen, smartphone, stir bar, ruler).
- Applying the research by implementing the protocols established at the study site.
- Collecting data and organizing it into tables.
- Entering data on the program website. (www.GLOBE.gov)
- Analyze the questionnaire data.
- Analyze the data collected through the implemented protocols.
- Reaching conclusions and recommendations.

Second: The location of the study:

The plan of this research was implemented in Umm Hani School for Basic Education (8-12) in the village of Al-Khubar in the Wilayat of Samail in the Dakhiliyah Governorate.

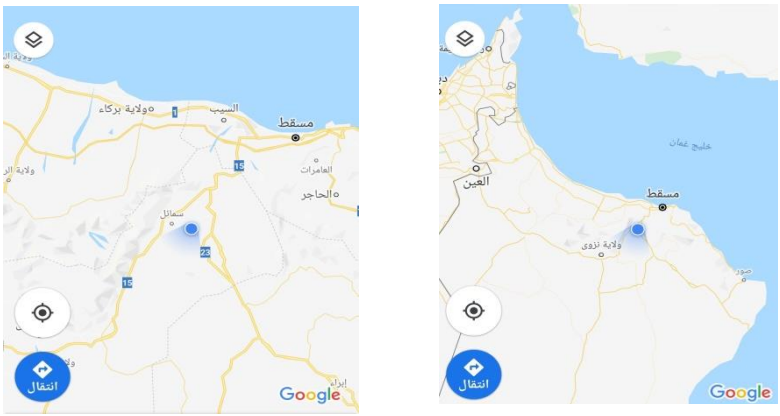
(Sultanate of Oman, Al Dakhiliyah Governorate, Wilayat Samail, December 2021 - January 2022 AD, the weather is moderate, water protocols and land cover have been applied).

The following table indicates the location coordinates data.

Table (3) the coordinates of the study site

Village	Al-khobar (samail)
Location coordinates (GPS)	23.02 N 58.01 E

The pictures below show the site maps.



Picture (1) geographical maps to determine the location of the search

Third: Data collection and analysis:

The data related to the first question was collected by publishing a questionnaire via Google Form to a random sample of the general Omani society that includes two questions:

1. Do you have knowledge about hydroponics?

2. Do you implement a hydroponic system in your home or farm?

The data related to the second question was collected by applying the water protocol and measuring the properties of conductivity, acidity, and salinity of the water used in the hydroponics system before and after adding the innovative solution from the rough plant (reed). The same data was also collected for the water used in hydroponics before and after adding nutrients available in the market.

Pictures (2) Applying the activities of the water protocol before and after adding the nutrient solution from the rogue plant (reed)

As for the answer to the third question, the land cover protocol was applied by measuring the plant height (the growth rate of cultivated plants) in the hydroponics system weekly during a period of one month from the application of the study.

Pictures (3)Application of the land cover protocol

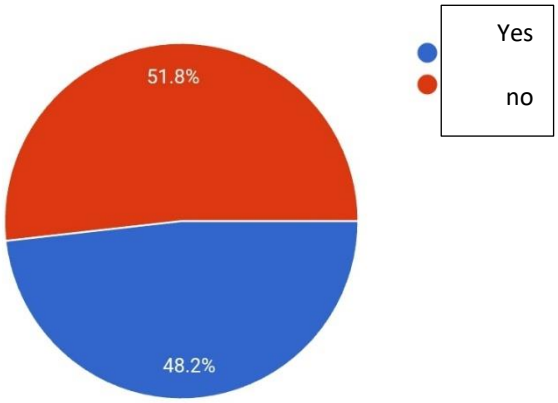
The results

To answer the first question in the research:

The following graphs show the results of the responses of the random sample members from the community to the questionnaire questions.

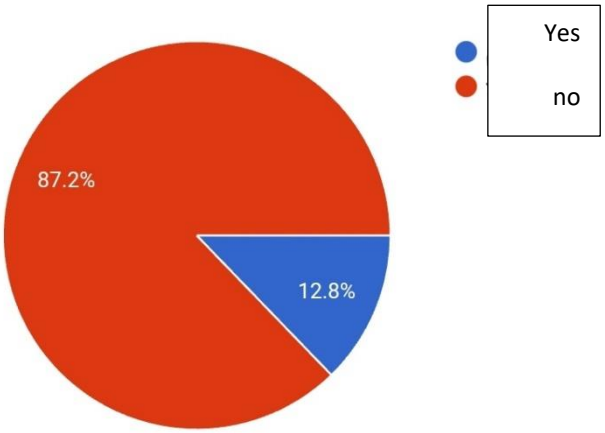
The questionnaire

1. Do you have knowledge about hydroponics?



Picture (4) The graphic representation of the responses to the first question in the questionnaire

2.Do you implement a hydroponic system in your home or farm ؟



Picture (5) is a graphic representation of the responses to the second question in the questionnaire

To answer the second question of the research:

The research team created the nutrient solution from the rogue plant (reed), as the GLOBE program team at Umm Hani School had previously

presented in 2018 a research on the use of rogue plant (reed) as a fertilizer for soil and plant cultivation. The current research derived the idea of employing the rogue plant (reed) based on the recommendations of that research (Al-Nadabia et al., 2018).

Rogue plant (reed) was used in the current research by harvesting the plant and then cutting it into small pieces and placing it on boiling water with the lid of the used pot is closed to make sure that the water absorb the components of the rogue (reed). Then the liquid solution was separated from the solid components. The conductivity, salinity and acidity data of the solution were measured and thus used to be a nutrient solution in a hydroponic system as a substitute for the nutrients available in the market.

Table (4) shows the data of the hydrological characteristics of the water used in the hydroponics system, which were collected from the study site using the tools of the GLOBE program (date 7/December 2021 AD). The table also shows the same data after adding the innovative nutrient solution from the Rogue plant (reed).

Table (4) Data of water samples

Characteristics of the water used in the hydroponics system	Conductivity µs	Salinity Ppm	Acidity pH
Before adding the nutrient solution from the rogue plant (reed)	786	854	8.36
After adding the nutrient solution from the rogue plant (reed)	928	1094	7.69

The nutrient solutions available in the market for the hydroponics system provides a good nutrient environment for plants in order to achieve the provision of conductivity and acidity data appropriate for plant growth and continuity of survival. The nutrient solution was created from the rough plant (reed) and the effect of adding it to water in the hydroponic system was followed up, providing the appropriate properties of conductivity and acidity suitable for the growth of the plants used in the research.

Conductivity and acidity were measured with devices available for GLOBE protocols

To answer the third question of the research:

The ground cover protocol was applied to the plants grown in the hydroponic system, by continuing to measure the length of the plant after using the rough solution feeder (reed) for two weeks. Then the length of the plant is measured after using the nutrients available in the market and designated for hydroponics for another two weeks and comparing the results.

The growth rate of the plant = the length of the plant after two weeks − the original length

Table (5) Tomato Plant Height Data Using Rogue Feeder

height of the plant at the beginning of the experiment (cm)	Plant height after one week (cm)	Plant height after two weeks (cm)	plant growth rate (cm)
4	5	9	5
3	5	8	5
5.5	6	9	3.5
4.5	5	8	3.5
6	6.5	10.5	4.5
4	5.5	11.5	7.5
6.5	6.5	8.5	2
6	6	9	3

Arithmetic mean of growth rate = sum of values \u200b\u200btheir number = 4.25 cm

Table (6) Pepper Plant Height Data Using Rogue Solution Feeder (Reed)

height of the plant at the beginning of the experiment (cm)	Plant height after one week (cm)	Plant height after two weeks (cm)	plant growth rate (cm)
3.5	5	6	2.5
6	6.5	7.5	1.5
4	5.5	9.5	5.5
4	5	5.5	1.5
9	8	10	1
5	6	6.5	1.5
4	4.5	4.5	0.5
4.5	7	11	6.5

Arithmetic mean of growth rate = sum of values / number = 2.56 cm

Table (7) Tomato plant height data using regular nutrients from the market

height of the plant at the beginning of the experiment (cm)	Plant height after one week (cm)	Plant height after two weeks (cm)	plant growth rate (cm)
5	6	8	3
5	6	8	3
6	6.5	9	3
5	6	9	4
6.5	7.5	10	3.5
5.5	6	9	3.5
6.5	7	9	2.5
6	6	8	2
6	7	9	3

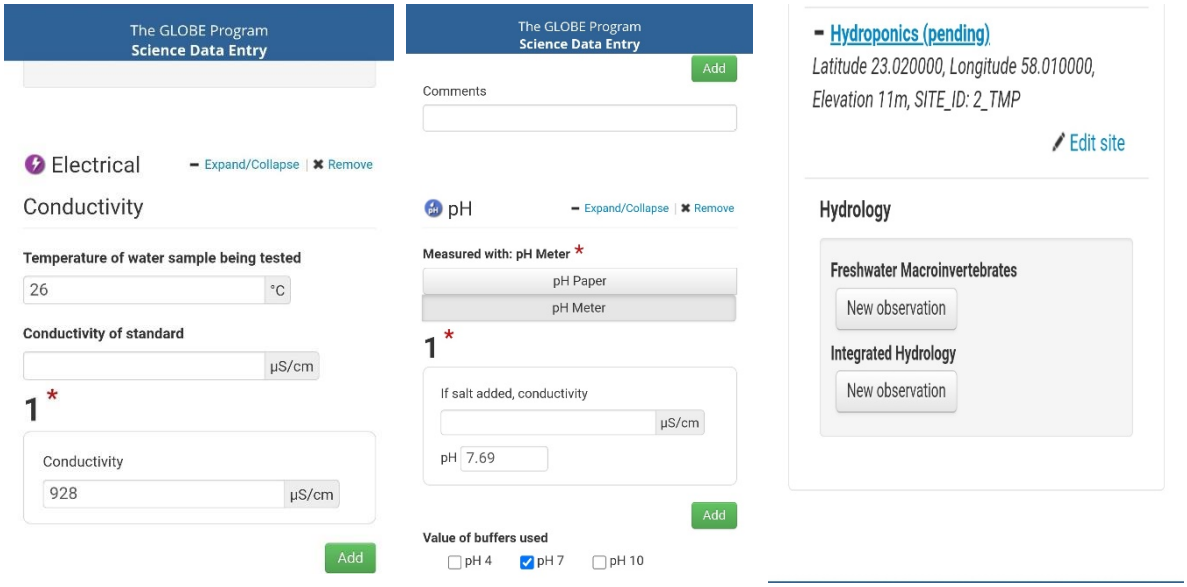
Arithmetic mean of growth rate = sum of values / their number = 3.06 cm

Table (8) pepper plant height data using regular nutrients from the market

height of the plant at the beginning of the experiment (cm)	Plant height after one week (cm)	Plant height after two weeks (cm)	plant growth rate (cm)
5	5.5	8	3
6.5	9	13	6.5
5.5	7	12	6.5
5	6	8.5	3.5
8	11.5	17	9
6	8	8	2
4	5.5	8.5	4.5
4.5	6	7	2.5
7	9	14	7

The arithmetic mean of the growth of the plant = the sum of the values \u200b\u200b\number = 4.94 cm

-The data was entered and sent to the GLOBE program website (www.GLOBE.gov) via the application (DATA ENTRY), where new work sites were added and the data collected through the search was entered.



Picture (6) Enter data on the site

Result discussion

First question answer:

The graph of the random sample responses to the questionnaire questions shows that 51.8% of the community members do not have knowledge about the hydroponics system. Therefore 87.2% of the community members do not apply hydroponic systems in their homes or farms. This Emphasizes the need to raise awareness and educate the community about the importance of hydroponics and its role in reducing the water depletion consumed in regular agriculture in the soil. In addition it plays a vital role in the quality and availability of the crop throughout the year, and reduces the harmful insects that can attack plants (Sanaglih, 2021). Moreover, it is important to spread awareness regarding the changing climate and to search for appropriate engineering solutions to confront it and using hydroponics can be one of the best solutions. As mentioned in (Sanajleh, 2021), the rationalization in water consumption through hydroponics technology is achieved by recycling water in a closed

cycle and using it many times through which it is condensed and delivered again to the cultivated plants.

The Globalization 3000 page in the Journal of Globalization and Man (2021) indicated that industrial agriculture is responsible for destroying soil and biodiversity around the world, as it consumes a lot of water and contributes significantly to climate change; So alternatives are needed, one of which is hydroponics.

The second question answer:

The data of the hydrological characteristics of the solution extracted from the rough plant (reed) shown in Table (4) indicated good specifications after adding it to the water used in hydroponics. The conductivity of the water reaches 928 µs and is classified according to the criteria for assessing the validity of irrigation water with an average salinity severity.

The following table indicates how to classify irrigation water on the basis of total dissolved salts (criteria for assessing water suitability for irrigation).

Table (9) Irrigation water salinity index

salinity index	Electrical conductivity micro siemens /cm at 25°C	salinity danger
A	<750	Low
B	750 – 1500	medium
C	1500 – 3000	High
D	3000<	Very high

The conditions that must be met in the nutrient solution:

1. The concentration of salts in the nutrient solution should not exceed the required rate, which leads to weak plant growth. Furthermore, the plant may die due to the plant's inability to obtain the water it needs. Therefore, when calculating the quantities of added salts, the concentration of salts in the water used to prepare must be recognized first. Nutrient solution.
2. The acidity number in the pH solution must be considered so that it is in the range of 6-7, and if it is lower than this, the solution becomes acidic which leads to damage to the roots of the plants. On the other hand, if it exceeds 7 by much, the solution becomes alkaline, and this leads to the precipitation of most of the elements in the form of Undissolved and does not benefit the plant. (Al-Hussaini, 2017)

The optimum pH for house plants such as tomatoes and peppers is (5.5-7.5) (the gardener and the shepherd, retrieved on 2/17/2022). Adding the nutrient solution from the rough plant (reed) contributed to lowering the pH of the water used in the hydroponics system, according to the data table. (4) From 8.36 to a suitable rate of plant growth (p H = 7.69) as well as a suitable salinity rate. The effect of this was evident by recording a faster growth rate in tomato plants using a nutrient solution of rough plant (reed) (4.25 cm within two weeks) compared to using regular nutrients from the market (3.06 cm within two weeks), according to the data of tables 5 and 7. As

well as for the pepper plant, a growth rate of (2.56 cm) was recorded with a solution of rough plant (reed) during two weeks.

Third question answer:

The data organized in Table (5, 6, 7, 8) showed the growth rates of plants during the study period, where the following table summarizes the average growth achieved in cm unit:

Table (10) growth rates of cultivated plants in cm

The plant	Use a nourishing solution of rogue plant (reed)	Use the nutrients available from the market
Tomato	4.25	3.06
Pepper	2.56	4.94

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The data indicated a good growth rate in the tomato plant by adding rogue solution (reed) in a way that exceeds the growth rate achieved using the nutrients available in the markets.

According to the conditions that must be met in nutrients (Al-Husseini, 2017), which was referred to on page 15, the salinity and acidity data provided by adding the nutrient solution from the rough plant (reed) to the water in the hydroponics system contributed well. Its contribution is based on providing acceptable levels of salinity and acidity required for the growth of houseplants used in this research. As well as with regard to the

appropriate level of salinity, which does not pose a significant risk to plant growth.

These results agreed with the study of (Al-Nadabia et al., 2018) in the effect of rogue plant (reed) on the growth of tomato plant, where plants grown in soil fertilized with rogue plant (reed) recorded the highest growth rates in the study.

As for the pepper plant, despite the fact that each of the nutrient solutions used in the research recorded good growth rates, the fastest effect in them is that of the nutrients available in the market.

It is also worth noting with regard to rationalization in water consumption that the work on this study requires adding water to the hydroponics system only once week. The used water is recycled in a closed cycle, which is used many times, through which it is condensed and delivered again to the cultivated plants. The researchers were convinced of the effective contribution of this technology in conserving water, which will undoubtedly serve the whole world with respect to the changing climate reality that the world is currently suffering from.

Conclusion:

The current research reached the reality of the use of hydroponics under the changing climate, and the impact of an innovative nutrient solution from the rough plant (reed) on plant growth in the hydroponics system. The sample members knowledge of the hydroponics varies and although 50% of the sample are familiar with the hydroponics, they do not actually employ it, except a very small percentage of them, about 12%. Therefore,

a great effort should be made to raise awareness about hydroponics technology and its role as one of the engineering solutions to face the changing climate.

The researchers benefited from the results and recommendations of a previous research in the exploitation of the rough plant (Al-Nadabia et al., 2018). They were able to create a nutrient solution for the hydroponic system by making use of the rough plant (reed) and obtaining a nutrient solution suitable for plant growth such as tomato instead of the use of nutrients available in the market. The results on the hydrological characteristics of water with a solution of rogue plant (reed) reached a (medium) severity of salinity (1179 µs - 753 µS) and a suitable acidity rate for the growth of house plants such as pepper, tomato, etc, (pH = 5.5 - 7.5). Therefore, it can replace the agricultural nutrients Water available in the market.

A similar study can be applied by selecting different types of houseplants such as leafy vegetables and others, with the aim of expanding the data and comparing with the current study. It is also possible to study the growth of plants on soil and compare with the growth in the hydroponics system in the current study. We also recommend the need to spread awareness about the importance of hydroponics and its role as one of the engineering solutions for the changing climate, and the possibility of exploiting the rogue plant (reed) and using it in the production of nutrient solutions for hydroponic systems.

Appreciation and thanks:

Praise be to God, prayer and peace be upon the Messenger of Allah ……..

On behalf of the current research team, we offer words of thanks and appreciation to our supervisor Mrs. Nawar Al-Rawahieh, and director of Umm Hani School for Basic Education, Mrs. Dalal Al-Nadabia and head assistant Mrs. Siham Al-Rawahieh, who fulfilled us with encouragement and support. We also thank Laila Al Lawati for her generosity and hosting the team members and introducing them to her different farming systems, especially with regard to hydroponics.

We would like to thank the central team of the GLOBE program for encouraging participation and providing advice and guidance regarding the research, as well as the program supervisors in Al Dakhiliyah Governorate.

Badge selection.

*I am an engineer; used hydroponics engineering in my research, Create a nourishing solution.

*I am a data scientist; collecting new different data and analyzing to get research findings.

*I make an impact; Contributed to raising community awareness, employing hydroponics technology and creating a nutritious solution that can be used.

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