Hydroponics is a soilless growing method based on water with the addition of fertilizers which supply all the necessary nutrients thus providing an integral response to the needs of the crop to maximize the yield and quality for commercial success.

The idea of growing plants in a nutrient solution without soil has been launched about 80 years ago. Relevant studies and research have been carried on as well as successful attempts of cultivating various crops in laboratory conditions or research greenhouses. In 1933, as part of the work on hydroponics performed at Berkeley University California, the researcher Dennis Robert Hoagland developed a formula based on a soluble concentration of 12 essential nutrients. This formula was named Hoagland Solution and has remained to this day the basis for the composition of hydroponic solutions (see table 1). In 1950, the formula was improved as it was found that half of the recommended concentrations are sufficient (formula called Half Hoagland) with chelated iron added.

Over the years, adjustments were made according to the different crops and growth management and the recycling operation of the system.

Table 1

Elements Doses	Concentration	
N	210	ppm
K	235	ppm
Ca	200	ppm
P	31	ppm
S	64	ppm
Mg	48	ppm
B	0.5	ppm
Fe	1to5	ppm
Mn	0.5	ppm
Zn	0.05	ppm
Cu	0.02	ppm
Mo		0.01
ppm		

- ppm = grams / cubic meter of water

What is the motivation for cultivating plants in a nutrient solution without a growing media instead of soil culture? The latter is common practice since prehistoric men who were food collectors that became food producers for their own needs and nowadays food commercial traders.

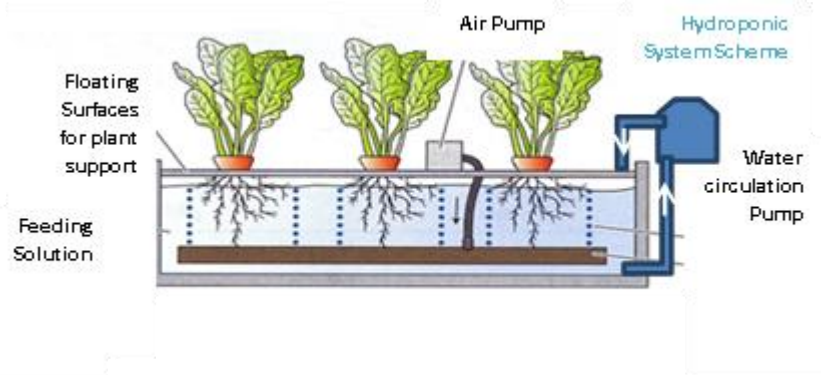
The roots of the plant absorb the nutrient elements as ions that are found in the soil solution, while the soil serves as a supportive media for the root system and a stabilizer of the plant. The soil contains clay minerals and organic substances that also respond to ions in the soil. Some of the ions undergo a chemical reaction and are not available to the plant roots, also an adsorption process involving the mobility of the ions between the ions in the adsorbed phase on the clay mineral and the ions in the soil solution.
The mobility of nutrient ions depends on their electrical charge: negative ions (anions) easily move with the wetting front during irrigation, while positive ions (cations) mobility is more limited as the content of clay mineral and organic substances increase in the soil because they have a negative charge. Therefore, nutrients supply during fertilization is not directly available to the root, it depends on the composition of the soil and the ability to supply the nutrient elements into the active root zone.
Soil culture requires heavy cultivation tools and the preparation of the fields-for seeding or planting. Spraying herbicides and fungicides are required and the installation of irrigation systems for the supply of water and fertilizer. Over the years, "soil exhaustion" occurs as a result of soil erosion from cultivation and from diseases and nematodes infection.

Regarding the limitations of soil cultivation, rose the idea of direct cultivation in a solution without soil. Thus, the question is why this method has not been developed and remained for about a century just a part of research and limited scale markets. Some reasons for this: hydroponic culture requires an accurate and controlled culture interface with the necessity for sensitive control systems that did not exist in the past or involved high-cost tools for agriculture. Investing in hydroponics infrastructure was expensive and required high-quality water sources or desalination facilities in order to serve the system. Soil vegetable crops require seasonal labor or picking hands and as long as the labor price was cheap there was no motivation for the farmers to look for advanced methods with less working force.

Hydroponics culture and technology development is progressing since the 90ies as we witness a number of changing factors:
Sophisticated and accurate operational and control systems at affordable prices, easy infrastructure installation at reasonable costs. Automation of systems is a significant saving factor in working hands. Optimal exploitation of space without paths enables the production of a crops 40% higher compared to soil culture.
It is possible to reach dense-growing cycles with no need for cultivations as required in the soil, such as, for instance, in leaf crops where hydroponics enable about 5-6 cycles per season compared to 2-3 cycles in the soil. The harvested crop can be directly put to sale, there is no waste due to diseases or soil residues on the roots or

external leaves. And moreover, the cost of cleaning and washing of the fruit or vegetable before the marketing is significantly lower.
The urban sector had a central role that contributed to the accelerated development of the hydroponics method, in the increasing use of mini hydroponics for growing vegetables, spices, and medicinal plants on the balconies of houses and windowsills.

Hydroponics is not a complicated method. It consists of ponds or molds placed on the ground or on tables with a permanent flow of water containing required nutrient elements according to the specific crop and necessary cycle pace. Water is continuously enriched with oxygen to stimulate good root system activity (see process scheme).
The plants are affixed to floating surfaces on the water, there is a progressing movement when there are small seedlings at one end while on the other end, mature plants that are easily picked. This conveying process of platforms on the water is not difficult and is based on friendly technology.



The complex part of the system resides in the control of the solution composition and in maintaining the needed salinity level (EC) and pH level. The irrigation and fertilization interface must be done with great care: a sudden dosage error or a pH change may cause significant damage to the culture. The farmer has to be highly skilled and attentive when handling the system.

Hydroponics is especially suitable for leaf crops.

Essential nutritional points

• The plant must be provided with an integral nutrient solution of macro and microelements, including calcium, magnesium, and sulfur, which are usually found in abundance in most of Israel soils and thus disregarded.
A combination of **"Or" fertilizer solution enriched with calcium and magnesium + MicroGat** concentrated microelements solution from Gat Fertilizers is a suitable and efficient solution. It Includes NPK, full array of microelements, calcium, and magnesium.
• Sulfur is supplied as sulfuric acid also used to balance pH to mild acidity.

Benefits

• No need for soil platform.
• Non consumed water and fertilizer remain in the system and are reused.
• Control of nutritional levels.
• Extremely low ecological and environmental pollution.
• Pest and disease treatment is easier compared to soil culture –net house
• Clean production - low waste.
• Release of the product to the market can be scheduled.
• Crop cycles throughout the year.

Drawbacks

• High initial investment in infrastructure compared to traditional soil cultivation - growing tanks, floating surfaces for anchoring plants, oxidizing mixers, "smart" fertilization system, and electronic systems for temperature control, humidity/ventilation, oxidation, salinity (EC), and pH.
• Sensitivity to power failures causing the sudden disruption of water circulation, and water mixing for oxidation.
• Need for constant monitoring of source water and culture solution. Frequent and regular laboratory tests.
• The system can easily destabilize and culture is then at high risk.

In conclusion, hydroponics cultures require precise skill and ability to obtain a balanced nutrient solution, Gat Fertilizers has a variety of fertilizers designated for hydroponics and a professional team of agronomists to support and advise the grower.

Shachar Tavor
Gat Fertilizers Agronomist
info@deshengat.co.il