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Hydroponics or the art of indoor growing **(by William Texier)**

In the last 20 years, tremendous improvements have been achieved in the art of indoor growing. In the late 70s in the US, manufacturers designed and created hydroponic systems of a small size, using the same technologies as the greenhouse industry. These are aimed at the general public and can be set outside on a balcony or a patio. They can be placed indoor too, in front of a well-exposed window, or in a closed space, under a light. They range from single plant units to true indoor gardens.

There are many benefits in using hydroponics at home, and among them:

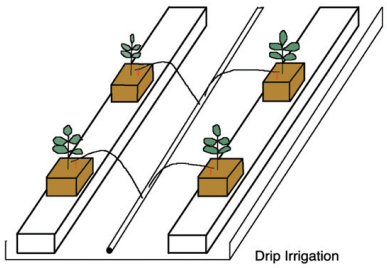
- A marked increase in the quantity harvested.
- The best flavor (when choosing the right varieties)
- A noticeable shortening of the vegetation/production cycle.
- An optimal use of the genetic potential of a plant.
- A much better control of plant nutrition. In fact, a meaningful research on plant nutrition could not be done before the development of hydroponics.
- And last but not least, a secure crop, protected from unfriendly interests.

Since these systems have a large supply of water, you could think of hydroponics as a way of leaving your plants unattended for quite a while. Wrong: their increased metabolism will require a good deal of attention on your part. This is not a way of saving maintenance time in your garden. It is a way of improving all the results.

Also, do not mistake these technologies for those called "Hydro cultivation". This term usually describes passive systems, using wicks. They belong more to the realm of gadgets than to cultivation techniques. In hydroponics, the nutrient solution circulates with a pump, in a dynamic way, regenerating continuously the level of oxygen in the solution.

I will try in this article to describe the most common systems. They can be roughly classified into 4 categories according to the technology used:

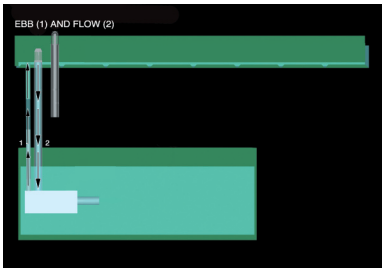
Drip systems:



From a main line, secondary small size plastic tubes (spaghetti lines) bring the nutrient solution individually to each plant. The circulation is set on a timer. Such a system is made of long, rectangular trays in which are placed slabs of rock wool or a similar medium (glass wool, coconut fiber, etc...). On this slab sits a cube in which the plant has been rooted. The spaghetti line brings the solution to the cube. A reservoir, situated below, collects the run off of the nutrient solution, which is then recycled. Or in many occasions, the run off from the solution is just discarded. Such a system can be as small as 30cm x 55cm.
Drip systems are reliable and easy to operate. They are well suited for beginners. To a certain extent, the medium protects the roots from sudden variations in temperature and hygrometry and most generally, from operator's error.
In these systems, the irrigation cycle is critical: too much water and the roots will rot through lack of oxygen, not enough and the salts are going to crystallize in the cube and interfere with the root's absorption.
There is also an ecological problem: you have to change the medium with each crop, generating wastes that cannot be recycled. It is one of the many problems faced by the greenhouse industry in Holland where rock wool is used on a very large scale for flower and food production.

Ebb and Flow:

In this system, the nutrient solution is brought from below, at the bottom of the tray, and allowed to fill it. At regular intervals, the solution is pumped from the tank into the root zone until the tray is flooded. It is



then allowed to drain back into the tank by gravity, through one or more drains drilled at the bottom of the tray.
The units are usually square and set off the ground on a frame. The reservoir is placed underneath in order to save space. To hold the plants in place, the tray can be filled with different materials such as rock wool or clay pebbles. It can also be left empty: A cover is placed on the tray with holes to insert the plants in. I don't like rock wool in these systems. I prefer the clay pebbles, which are more ecological and less prone to algae infestation. As for the one with a cover, they offer no protection for the roots and I would not suggest them for a beginner.
By moving slowly the water level up and down, the "Ebb and Flow" system provides an excellent oxygenation, a primary condition for a good hydroponic system.
Here again the watering cycle is crucial to avoid damage to the roots through excessive moisture or dehydration. They are very good systems but it take time to get used to them. It is not uncommon to experience some frustration in the first trials.

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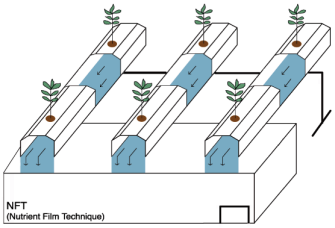
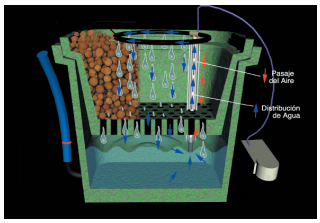
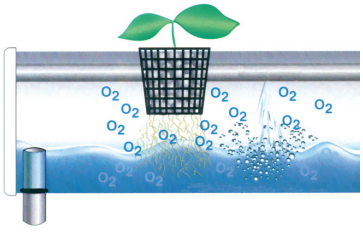


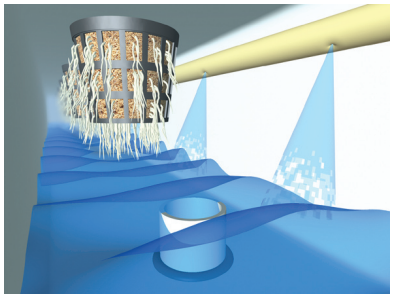
The initials stand for Nutrient Film Technique. Developed in England by A. Cooper in the 60's, these are the first of the true water culture systems.
They are among the easy ones to put together from supplies found at the local hardware store.
As the name implies, the nutrient solution is circulated as a very shallow, constant flow. A board is placed on a slightly slanted metallic frame, and on top of it, a plastic sheet. The young plants are lined up on the plastic, rooted in a cube of rock wool or similar medium. The plastic is folded and stitched to form a trough in which the nutrient solution will circulate. A gutter, at the low end of the frame, caches the solution to bring it back to the reservoir.
As far as oxygenation is concerned, those systems are good. However, the crop would not survive an extensive power failure. If the failure happens at the wrong moment, such as a very hot day, the plants will survive only a few hours. Also, when the plants become too big, the root mass tends to be compressed.

Aero hydroponics:



This technology was developed concurrently in Israel and at Davis University, California in the 70's. It is winning ground from the most traditional methods, especially in the countries newly won over to hydroponic commercial production such as Australia.
Being closed circulation systems, they are not a threat for the environment. On a large-scale operation, where pollution is a concern, they are one answer to the "run to waste" technology, widely used today. Also, with their dynamic water circulation, they help remove gas from the nutrient solution. One can keep a plant for months without toxic accumulations in the root zone.
Aero hydroponics use either air pumps or water pumps.
Air pumps power small size systems: a small bucket with pierced bottoms, filled up with clay pebbles used as a physical support for the plants (irregular pebbles work best) which fit into a second, larger bucket: the reservoir. A low wattage pump, the type that is used for fish tanks, oxygenates the water at all times. Through a pumping column the nutrient solution rises to the top of the unit. It then flows over the roots by gravity, back to the bottom bucket. Those pots are excellent for single large plants. They can be grown for years, until they reach surprisingly large sizes. They are very good units but, unless you are hooked up on a secondary reservoir, you have to keep a keen eye on them: in hot weather, a large plant will use up the water supply in 2-3 days.
On a larger scale, there are modular units using water pumps: Tubes, drilled to accommodate "grow cups" in which a handful of the same clay pebbles provide the physical support for the plants. The nutrient solution covers the root zone to a depth of about 8cm. It is injected into the growing tube with dynamic jets. The solution gets oxygenated when traveling in the air (hence the name Aero hydroponics). The liquid might circulate all the time or the pump can be shut at night. These units exist in all sizes, ranging from 2 x 1m up to 30 x 7m!
They are my favorite. They provide a saturation level of oxygen in the root zone and consequently a quasi-magical growth rate. Also they do not generate waste: The cups and pebbles can be





reused over and over again. However, the roots being directly immersed in water, the temperature in the root zone is critical. These units work best in a well-ventilated space.

What to choose?

There is no easy answer to that question. It depends on the personality of the user, of his goals. Of course, the financial means and the time available for the project need to be considered. As a general rule, the better a system, the faster the growth and the more one has to be vigilant.

Such systems generally do not come cheap. They are manufactured by medium size companies, which lack the means of production of the big industry. However any good handyman can build one himself with a little time, cleverness and a few plastic fittings bought from some of the manufacturers as well as hardware stores. This relatively high cost should not stop you. The investments are soon recovered in yield... with the added pleasure of discovering in your own home technologies accessible, until now, only to professionals.

Whatever your choice, some general principles apply to all crops and all types of indoor growing:

- The room where you have your plants should be well ventilated. It is difficult to overdo it! If the external weather allows it, continuous ventilation will eliminate the excess of humidity and bring in the much-needed CO_2 to your plants.
- If there is no air draft, circulation fans will homogenate the air in the room, eliminating pockets of hot, humid air. They will also increase the structural strength of your plants.
- When using lights, don't forget that they have a very limited range of efficiency. You have to keep your light source as close as possible from the tops of your plants... without burning them. This distance varies according to the type of illumination used. You should prune the lower branches receiving little light.
- In summer, when using lights in an enclosed space, you could turn them on at night to take advantage of the cooler air.
- The nutrient solution should be kept as cool as possible to keep a maximum oxygenation in the root zone. Ideally it should be around 18° C. It should be slightly more acidic than in a soil situation, with a pH from 5.5 to 6.5. The mineral salts dissolved (or Electro Conductivity – EC) should be around 0.4 - 0.8 EC for cuttings, 1.6 for young rooted plants, 1.6 - 2.0 for the vegetative stage, and 1.6 - 1.8 EC for the flowering and fruiting stages.
- The choice of a nutrient is of prime importance: By definition, the medium used is neutral and the nutrient solution is the only source from which your plant can feed. It has to be complete and balanced. Since the absorption is fast, the salts have to be pure. Impurities would lead to toxic accumulations. Choose preferably liquid or perfectly soluble nutrients so you don't plug the feeding lines. Read the labels and do not hesitate to run your own tests, comparing different nutrient brands. A well-formulated nutrient is a prime contribution to the success of your growing operation.

To conclude:

For more than 20 years, I have grown my own plants in hydroponic systems. I always plant a few specimens in soil for control. After all this time, I still marvel at the difference. Only very few species do not like this type of cultivation, generally plants which are difficult to transplant. They have to be sown in place, which can be sometimes tricky in a hydroponic unit.

The quality of the production is essential for the home grower. To the best of my knowledge, no hydroponic nutrient around the world has obtained an organic certification (even though some claim to be "organic"). In fact, in order for a nutrient to be organic, it has to be transformed by living organisms and made available to plants. In a hydroponic system, these organisms compete for oxygen with the plant. They thrive in the well-oxygenated nutrient solution and develop to the point that they colonize the system. After a while, they accumulate on the roots and block the plant's intake. It is however possible through these technologies, to obtain produce of a high nutritional value with a taste at least equal to the best soil grown.

During all these years, I have always tried to create a type of cultivation as natural as possible, even if plastic tubes seem a far cry from nature. I have never used pesticides (or, of course, herbicides). It is better to fight pest with the help of beneficial insects and other living organisms. Creating, in an artificial situation, a biologically diversified and relatively stable natural microcosm, is a fascinating challenge.

Whatever technology you choose; even if you cannot let go of the dubious pleasure of dirtying your hands in soil, growing plants is an infinite source of pleasures, one I hope you discover by yourself

If you want to know more about the systems described please don't hesitate to contact me:

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