Why NFT is the best hydroponic system beginners should avoid

Nutrient Film Technique (NFT) is a hydroponic growing system that uses flat channels with nutrient solution flow – in the form of a thin film at the bottom of the channels – in order to grow plants. An NFT system will maintain maximum oxygen exposure to plant roots and a consistent nutrient supply, providing ideal conditions for plants. However, while NFT systems are extremely popular in large commercial operations, small scale growers and hobbyists rarely use them with the same success. Why is it that professionals like NFT systems so much, but yields decrease when small scale growers try it?

A commercial hydroponic NFT system

The fragility of NFT

The NFT setup provides an ideal set of conditions that is hard to maintain without significant effort. These systems demand control over a large variety of variables. This includes the flow of nutrient solution, the temperature of the air inside the channels, the chemistry of the solution and the sterilization of the nutrient solution. These are also all critical failure points for an NFT system. It is common for NFT setups to fail because of power failures, roots clogging channels, diseases spreading like wildfire, solutions becoming too hot or too cold, etc. The more things you have to control, the easier it is to fail to control one of those properly.

Commercial growers will generally have a lot of people and resources devoted to the monitoring of all these conditions and adequate standard operation procedures will generally be in place to address all these potential points of failure. Large growers often start from turn-key solutions with already well established expectations for issues and their solutions, something that small growers generally lack. By design, NFT requires a lot of planning for contingencies, small growers and amateur growers don't do this as well as large companies.

Decision skills

One of the most critical aspects of NFT systems is that the time between decisions and consequences is quite fast. If roots grow to the point where a channel is being significantly obstructed and a grower does not realize there is a problem and acts fast, then the crop will be very negatively affected. In one crop I consulted with, a 24 hour delay in noticing the start of a fungal disease, generate a massive loss of plants in the crop. The solution was not being adequately sterilized in recirculation, which was a huge oversight and failure point for the crop. Thankfully, this grower was producing lettuce – which is easier to recover from as the crop cycle is short – but this can be devastating for a flowering plant grower, where crop cycles are much longer.

NFT rapidly spreads disease across plants. Taken from this paper.

This ability to find problems fast and solve them quickly requires a lot of focus and attention. Small scale growers are generally distracted by many other aspects of the crop, from financials and distribution in small scale commercial operations, to just regular life and normal jobs in family setups. For this reason, these problems generally go unattended in these crops, which leads to problems from lower yields, to total crop failure.

A lot of small problems

Perhaps most insidious, is the fact that many problems in an NFT setup can go completely unnoticed during a crop cycle, eating at yields before they are apparent. While commercial growers will have expectations set by consultants and system builders, the small scale grower will have no idea that certain things need to be looked at within a crop cycle.

For example, channel length can be critical in NFT setups, as plants that receive the feed at the start of a channel can deplete a solution from key nutrients by the time it reaches the end of the channel. This issue can go on through an entire crop cycle without the grower ever noticing anything except reduced yields. This might lead a grower to think that the NFT system is somehow leading to lower yields, while it is their particular implementation of NFT and not NFT as a whole that leads to worse results.

Small scale growers tend to have less time and resources, so they will tend to ignore problems that are not very obvious. The sum of all these problems will tend to cause a substantial erosion of yields. In my experience, small scale growers will, on average, achieve much better results with systems that are more forgiving than with a potentially more productive but substantially more complicated setup.

Plants in NFT setups can grow huge roots that can easily clog drains or prevent proper flow across the channel. Trimming roots when this happens is fundamental for system survival.

Why large scale growers use it

You might be thinking, why do commercial growers bother with NFT then? If it is so complex and prone to failure, then why in the world would you choose a system like this? The answer, is that NFT can be a very high yielding, low cost and reproducible alternative at a medium to large commercial scale. It avoids one huge cost – which is the purchase and labor costs associated with media – and focuses all energy into the production of plants. An NFT crop is also much more efficient from a water and fertilizer usage perspective (1). This means that, for a large scale commercial grower, dealing with the complexities of an NFT system is preferable to dealing with the additional costs, labor and inefficiencies of a media based system. Having to handle way less nutrient solution volume, no media and getting basically the same or superior yield, is a no-brainer for commercial growers.

A medium to large scale greenhouse will have people dedicated to growing, whose main job will be to monitor the crop and ensure that it is performing as specified by the manufacturer. With more than 70 years of experience in the setup of hydroponic crops, many companies offer turn-key solutions that have clearly set management procedures and outcomes for several different plant species. This is especially true for leafy greens, cucumbers, tomatoes, peppers and strawberries, all very commonly produced using NFT systems.

What should the little guy do then

For commercial growers, the benefits of NFT often overcome its disadvantages. However, for the small grower looking for more reliable production of crops, even if it means at lower fertilizer and water use efficiency, it often doesn't make sense to go with NFT setups. For small growers who want to avoid media, deep water culture (DWC) offers an easier and more reliable alternative. For those wanting to grow with lower starting costs, open media-based systems give the best success rates, even if this implies significantly lower efficiency from almost all points of view.

If this is your first try at hydroponics or if you want to go with a small scale commercial setup, my advice would be to go with a system that is more forgiving and that you have the time and skill level to properly manage. Once you master these systems, you can try NFT, but bear in mind that your initial results might be worse than what you were doing before, just because the level of skill and knowledge required to successfully manage an NFT setup is substantially higher.

Disinfection of nutrient solutions in recirculating hydroponic systems

Plant growing systems that recirculate nutrients are more efficient in terms of fertilizer and water usage than their run-to-waste counter-parts. However, the constant recirculation of the nutrient solution creates a great opportunity for pathogens and algae to flourish and colonize entire crops, with often devastating results. In this post, we are going to discuss the different alternatives that are available for disinfection in recirculating crops, which ones offer us the best protection, and what we need to do in order to use them effectively. I am going to describe the advantages and disadvantages of each one so that you can take this into account when choosing a solution for your hydroponic crop.

Disinfection of recirculating nutrient solutions has been described extensively in the scientific literature, the papers in the following links (1,2,3,4) offer a good review of such techniques and the experimental results behind them. The discussion within this post makes use of the information within these papers, as well as my personal experience while working with growers all over the world during the past 10 years.

A slow sand filtration system will be effective at filtering most fungal and bacterial spores, but is slow. Image taken from here.

In order to kill the pathogens within a hydroponic solution, we can use chemical or non-chemical methods. Chemical methods add something to the nutrient solution that reacts with the molecules that make up pathogens, killing them in the process, while non-chemical methods will add energy to the nutrient solution in some form or filter the solution in order to eliminate undesired microbe populations. Chemical methods will often affect plants – since the chemicals are carried away with the nutrient solution – and require constant adjustments since the levels of these chemicals within the nutrient solutions need to be controlled quite carefully.

Chemical methods include sodium hypochlorite, hydrogen peroxide, and ozone additions. From these choices, both hypochlorite and hydrogen peroxide have poor disinfection performance at the concentrations tolerated by plants and are hard to maintain at the desired concentrations through an entire crop cycle without ill effects. Ozone offers good disinfection capabilities but requires additional carbon filtration steps after injection in order to ensure its removal from the nutrient solution before it contacts plant roots (since it is very poorly tolerated by plants). Additionally, ozone sterilization requires ozone sensors to be installed in the facility in order for people to avoid exposure to high levels of this gas, which is bad for human health. In all of these cases, dosages can be monitored and controlled to a decent level using ORP meters, although solely relying on ORP sensors can be a bad idea for substances like hypochlorite as the accumulation of Na and Cl can also be problematic.

The most popular non-chemical methods for disinfection are heat treatment, UV radiation, and slow sand filtration. Slow sand filtration can successfully reduce microbe populations for fungi and bacteria but the slow nature of the process makes it an inadequate choice for larger facilities (>1 ha). Heat treatment of solutions is very effective at disinfection but is energetically intensive as it requires heating and subsequent cooling of nutrient solutions. For large facilities, UV sterilization offers the best compromise between cost and disinfection as it requires little energy, is easy to scale, and provides effective disinfection against a wide variety of pathogens if the dosage is high enough. It is however important to note that some UV lamps will also generate ozone in solution, which will require carbon filtration in order to eliminate the ill effects of this chemical. If this wants to be avoided, then lamps that are specifically designed to avoid ozone generation need to be used.

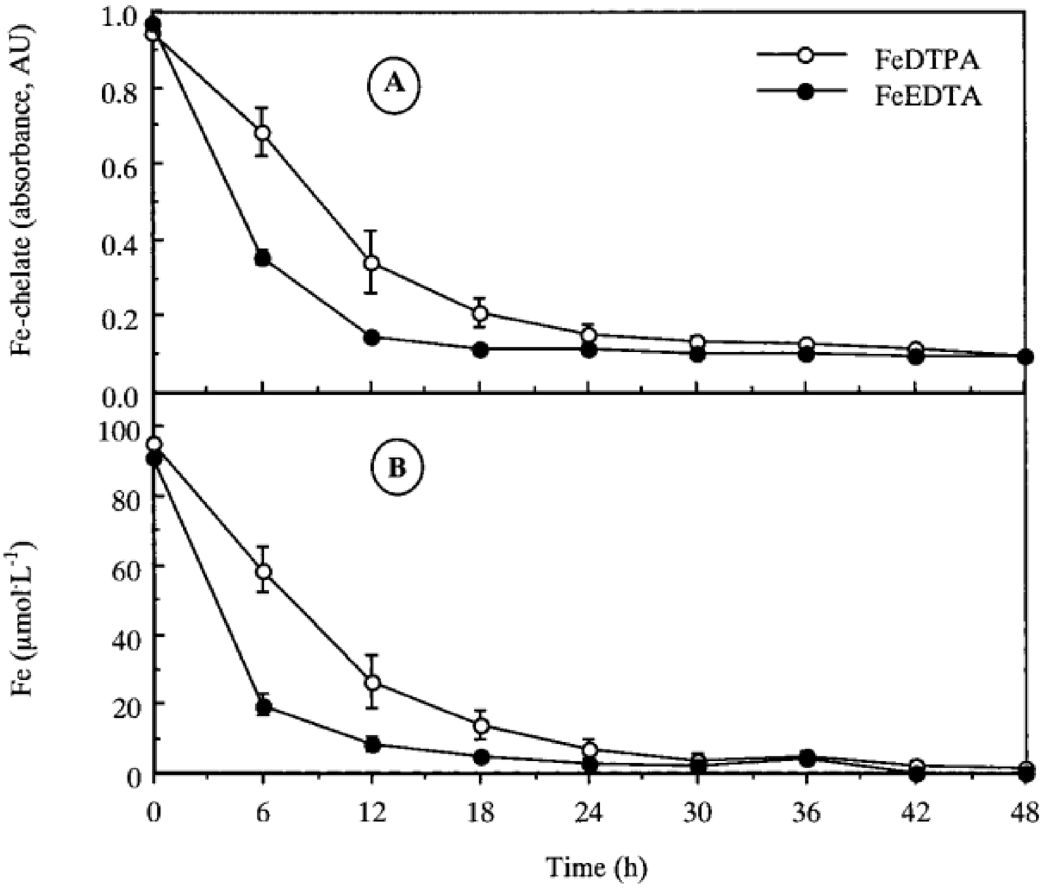

Fig. 3. (**A**) FeDTPA and FeEDTA determined spectrophotometrically at 260 or 258 nm, respectively, and (**B**) soluble Fe determined by atomic absorption spectrophotometry for a lab-prepared nutrient solution. Nutrient solutions were 5× stocks (14.28 mmol·L^{-1} N, 17.9 µmol·L^{-1} Fe is 1×) irradiated at 30 °C with a HID light source providing 500 µmol·m^{-2}·s^{-1} (330–800 nm) measured at the surface of a 500-mL LDPE container. No absorbance was detected in solutions without Fe-chelate. Vertical bars indicate SE (*n* = 4). If none are shown, they fall within the dimensions of the plotting symbol.

Loss in soluble Fe as a function of UV radiation time. Taken from here. Note that this is irradiation time -not nutrient solution life – in a normal crop it will take 10x the time to accumulate the level of radiation since solution is not under radiation for most of the time.

If you want to use UV sterilization, you should carefully consider the power of the lamps and the flow rate needs in order to ensure that you have adequate sterilization. Most in-line UV filters will give you a flow rate in GPH at which they consider the dosage adequate for disinfection, as a rule of thumb you should be below 50% of this value in order to ensure that the solution is adequately disinfected as some pathogens will require radiation doses significantly higher than others. You can also add many of these UV filters in parallel in order to get to the GPH measurement required by your crop. UV sterilization also has a significant effect on all microbe populations in the environment (5) so consider that you will need to inoculate with more beneficial microbes if you want to sustain microbe populations in the plants' rhizosphere.

With all these said, the last point to consider is that both chemical and UV sterilization methods will tend to destroy organic molecules in the nutrient solution, which means heavy metal chelates will be destroyed continuously, causing precipitation of heavy metals within the nutrient solution as oxides or phosphates. As a rule of thumb, any grower that uses any method that is expected to destroy chelates should add more heavy metals routinely in order to replace those that are lost. To calibrate these replacements, Fe should be measured using lab analysis once every 2 days for a week, in order to see how much Fe is depleted by the UV process. Some people have tried using other types of Fe chelates, such as lignosulfates, in order to alleviate this issue as well (6).