Hydroponics nutrients and microgreens

One of the most important goals in microgreens is to maximize the amount of weight gained by shoots from seed to harvest. Since the entire upper body of the plant is harvested and plants are sold by weight, maximizing the weight gain is vital in order to obtain the highest possible margins in a crop cycle. Hydroponically cultured microgreens offer the grower an unprecedented control over the microgreens' nutrition, with the ability to tightly control nutritional parameters in order to maximize this weight. In this article we are going to take a look into the scientific literature surrounding microgreens and what we know about maximizing their yield and quality using nutrient solutions. I will use the table below to reference different articles in the literature.

Number	Species	Studied	Link
1	Broccoli	FlograGro, sterile, compost	https://www.frontiersin.org/articles/10.3389/fnut.2017.00007/full
2	Purple Cabbage	Nutrient sol conc	https://www.scielo.br/scielo.php?pid=S1983-21252019000400976&script=sci_arttext&tlng=en
3	Table Beet	Calcium Nitrate	https://www.tandfonline.com/doi/abs/10.1080/19315261003648241
4	Radish	Calcium Chloride	https://bearworks.missouristate.edu/theses/3328/
5	Basil	Sodium Selenate	https://onlinelibrary.wiley.com/doi/abs/10.1002/jsfa.9826

Published articles talking about hydroponic nutrients and microgreen yield or quality

Despite the overwhelming growth in the microgreen industry during the past 10 years, the amount of research looking into microgreen nutrition has been surprisingly limited, with only a handful of papers looking at the relationship between nutrition and yields or quality. Paper one contains a comparison between microgreens grown in either compost, sterile water or a solution using a 0.4% FloraGro Advanced Nutrient solution (4mL/L). The results show clear weight benefits from using hydroponic nutrients, with the weight being markedly higher (mean of 24.64g vs 21.01g) between the sterile and hydroponic treatments. However the concentration of different minerals was actually lowest in the plants using a hydroponic nutrient.

Table 3: Shoot fresh weight per plant and per population of 'Early Wonder Tall Crop' table beet at 15 days after planting in response to seed ball and fertilizer treatments.

Seed treatment (ST)	Fertilization treatment (FT)[a]	Shoot fresh weight ($g \cdot m^{-2}$)	Shoot fresh weight (mg/shoot)
Nontreated	Check	2705h	166e[b]
	CN	4207f	268d
	SF	4676e	268d
	0.5 CN + 0.5 SF	4676e	284cd
	CN + SF	5469cd	299cd
Pregerminated[c]	Check	3391g	298cd
	CN	5087de	362b
	SF	5649c	306c
	0.5 CN + 0.5 SF	6294b	362b
	CN + SF	6937a	415a
Interaction $LSD_{0.05}$		444	36
Significance			
ST		***	***
FT		***	***
ST × FT		*	**

*,**, ***Significant at $P = 0.05$, $P = 0.01$, or $P = 0.001$, respectively.
[a]Check = no additional fertilizer added to the peat-lite; CN = preplant addition of solid $Ca(NO_3)_2$ at 2000 $mg \cdot L^{-1}$ of N (150 $mL \cdot L^{-1}$ of peat-lite); SF = daily application of 150 $mg \cdot L^{-1}$ of N solution fertilizer from 21-5-20; 0.5 = one-half rate.
[b]Means within a column followed by the same letter are not significantly different by $LSD_{0.05}$.
[c]Pregerminated = seed ball incubation in fine (grade 5) vermiculite with 150% water for 5 days at 20°C.

Table taken from article number three

Papers three and four look at different forms of Ca nutrition – either Ca chloride or Ca nitrate – and different ways to apply this treatment to see if it makes a difference in microgreen production. Paper three, shows a statistically significant gain in weight when using calcium nitrate, either applied into the media pre-cultivation or applied within a nutrient solution. The best results were found when both treatments were carried out and represented an increase of more than double in terms of weight over the control. The fact that paper four fails to show a consistent increase in yields using Ca chloride, suggests that this has to do mainly with the nutritional contribution of the nitrate and not the calcium ions.

Paper two is rather interesting, as it looks into different nutrient solution strengths (either 0, 50 or 100%) using a solution published for hydroponic forage. The results – in the table below – clearly show that there is a strong weight gain as the nutrient solution concentration increases, again showing that at a full strength solution there is an expected increase of more than 2x in the final weight. However this comes – in agreement with paper one – at the potential expense of nutritional value. The paper shows a significant decrease in carotenoid concentration when nutrient solution strength increases, which the paper hypothesis is caused by high nutrient concentrations slowing down plant metabolism. This hypothesis is however hard to reconcile with the larger and heavier plants.

Table 2 Effect of cultivation substrate and nutrient solution concentration on shoot fresh matter yield (SFMY) and shoot dry matter yield (SDMY), shoot height at harvest (SHH), and total soluble solids (TSS) content of purple cabbage microgreens (*Brassica oleracea* var. *capitata f. rubra*) in a recirculating system. Porto Alegre, Brazil, 2018.

Factors	Tratamentes	SFMY ($g\ m^{-2}$)	SDMY ($g\ m^{-2}$)	SHH (cm)	TSS (°brix)
	S1 (CSC® Vermiculite)	1829.52 [ns]	74.01 [ns]	6.86 [ns]	3.62 [ns]
Substratos	S2 (Beifiur® S10)	1761.30	79.21	6.89	3.64
	S3 (Carolina Soil® seedling)	1795.73	75.70	6.83	3.73
	S4 (Carolina Soil® organic)	1793.57	81.10	7.19	3.82
	C1 (0%)	1111.31 c*	64.34 c	5.00 c	5.03 a
Concentration Nutritive Solution **	C2 (50%)	1933.16 b	78.62 b	7.36 b	3.37 b
	C3 (100%)	2340.62 a	89.59 a	8.48 a	2.72 c
	Mean	1795.03	77.52	6.94	3.70
	CV (%)	16.34	11.29	6.83	14.45

[ns] not significant by the Tukey's test at 5% probability;

* means followed by the same letter in the columns are not different by the Tukey's test at 5% probability.

** initial electrical conductivity (ECi) established for the three evaluated nutrient concentrations (0%, 50%, and 100%) in the nutritive solution: C1 = 0.0; C2 = 1.20, and C3 = 2.0 dS m^{-1}, respectively.

Table taken from article number two

Article five is also an interesting example of the use of microgreens to carry out antioxidant supplementation. Sodium selenate was used to prepare a solution to treat basil seeds and the resulting microgreens were found to be fortified with selenium. This might be an interesting way to incorporate mineral micro nutrients into microgreens and therefore increase their presence within our diet. However there is also the potential to hyperaccumulate these nutrients, so experiments of this kind should not be done with adequate care and lab analysis to ensure proper doses of these micro nutrients.

From all of the above it seems quite clear that the research of hydroponic nutrients in microgreen production is in its very early infancy. So far only a handful of research papers have been published on the subject and the conclusions so far seem to be that hydroponic nutrient solutions – in a couple of different forms – tend to significantly increase microgreen production weights. However it is also clear that there is a strong interaction with the nutritional value of the microgreens and using nutrients can in fact lead to decreases in the nutritional value, despite the significant weight gain from the process.

The echoes of the above can be seen in a wide variety of anecdotal experiences on youtube channels and forums. Growers running side by side experiments seem to have found the same phenomena (see this video for an example), where adding nutrients increases yields significantly but at the expense of some of the flavor – and potentially nutritional – characteristics of the microgreens. Some growers have therefore chosen to avoid nutrients – to preserve flavor qualities – while others have chosen to use nutrients because of the increases in marketable appearance and yield.

There is a lot of research to be done on the subject. It would certainly be interesting to find out if we could somehow have the best of both worlds.

Microgreen production at home: Getting the materials

Microgreens are plants that are harvested for consumption during the seedling stage, normally a week or two after a seed has been germinated. They can be one of the most nutritionally dense plant foods out there, given that they contain a lot of the nutrition already present in seeds plus phytonutrients derived from the beginning of the plant growing process (see here).

For these reasons and the fact that they can be grown in small amounts of space, all year round, I have decided to do a small home microgreen project in order to produce a relatively large amount of microgreens for home consumption. Since I have no experience creating setups of this type – I have worked in hydroponic forage productions but never microgreens for human consumption – I decided to look for the best possible setup and in the end decided to base this project on the setup described in this youtube video, following some of the advice given by this microgreen grower. *Note that I do not know if any of the financial claims in this video are true or even likely to be true, I just liked the growing setup configuration.*

I intend to produce microgreens like these

Using my own experience in hydroponics I then went for the materials that I thought best matched what was given in the video and ended up with the following list:

1. Styrofoam covers for trays (these you can definitely get cheaper, but these are the best compromise I could find on amazon, they are used in the dark phase of the

germination process)
2. Rack to place the trays in (there might be cheaper ones but I needed something aesthetic as it will be visible in my apartment)
3. LED lights to use for growing (2 per rack section) (cool spectrum to limit etiolation, 2 tubes per rack space)
4. Trays (pizza dought box) . (note that this is polypropylene, not fiber glass, 5 trays fit in the rack)
5. Coco mats
6. Sprayer
7. Bamboo sticks used as separators in trays
8. Broccoli seeds (organic, untreated)

These are all the materials – besides water and hydrogen peroxide – that should be required to reproduce the basic setup I want to recreate. With this setup I will be able to grow 5 18×24″ racks at the same time, which is a lot of microgreens for home consumption. My plan is to experiment with broccoli seeds first – which are relatively cheap and easy to germinate – then move onto other plants that might be more expensive and difficult to germinate. Broccoli plants should germinate in 1-2 days and should be completely ready for eating in around 7 days. This can be a big difference compared with something like oregano which might take 6 days to germinate and then an additional 7-10 days to be ready for consumption. You can use a reference graph with the production times of different microgreens here.

I also have significant experience with enhancing germination, so this setup will provide me with the ideal conditions to test different germination treatments on the plants. Hopefully I will be able to cover those in this blog. This project might also be the perfect opportunity to start a youtube channel so that you guys can experience the entire setup first-hand.