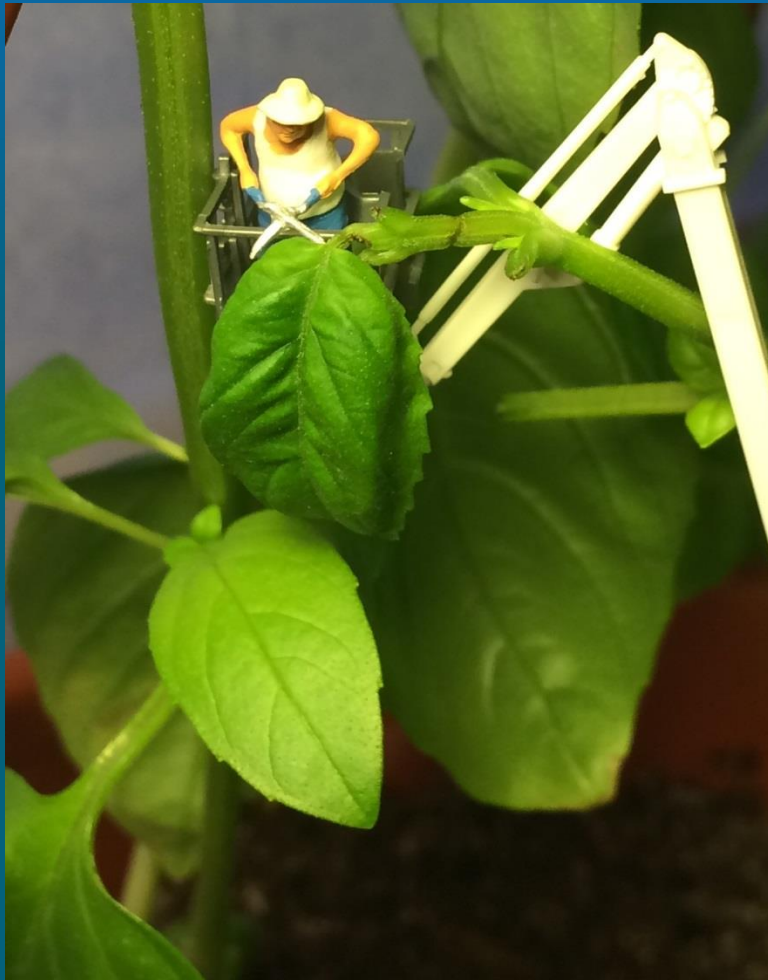
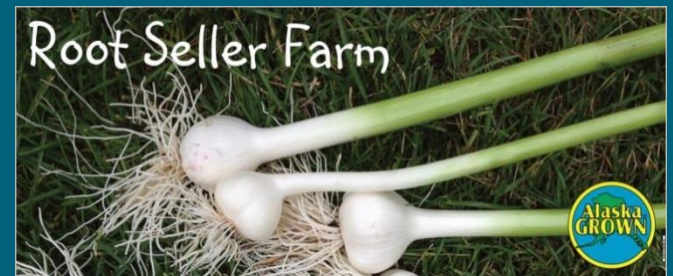


Root Seller Farm *Hydroponic BASIL*



Small Scale Hydroponics:
The **BIG** News from a
Small Operator



Hydroponic BASIL

Vertical Flood and Drain System *BASIL TOWER*



8/31/15



9/5/15



9/13/15



10/9/15

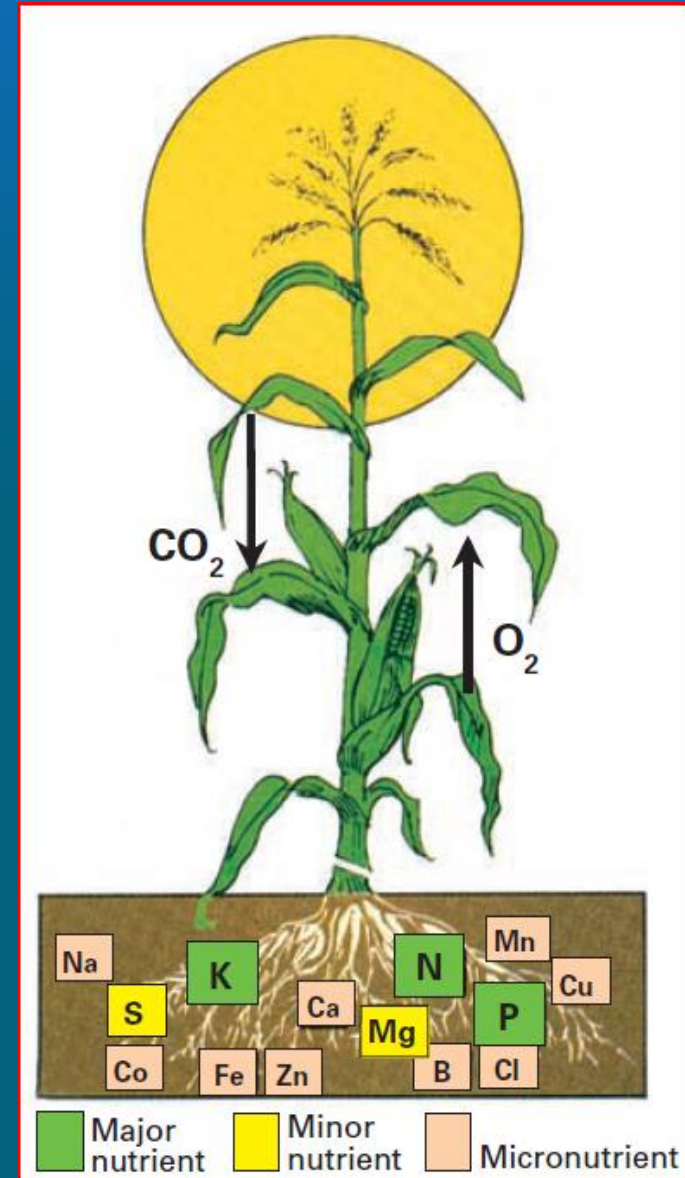
Basil Tower 1.0 (2015) in the dining room:

Components: System (types, substrates, lighting, heating)
Nutrients, CO₂, and
WATER...

Hydroponic BASIL

Simple plant physiology:

- $\text{CO}_2 + \text{H}_2\text{O} + \text{light} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2$
- **N** from N-fixation (*Ammonia-Nitrite-Nitrate*)
essential Amino Acids - Proteins
- **P** as phosphorus from soil (guano)
phospholipids, ATP, DNA, often limiting
- **K** essential for growth, sugar movt,
resistance to stress (potash)
- **Minor nutrients & Micronutrients**
 - growth and metabolism
 - proteins, fats, chlorophyll, cell walls, enzymes, osmosis and ionic balance, N-fixation



Hydroponic BASIL

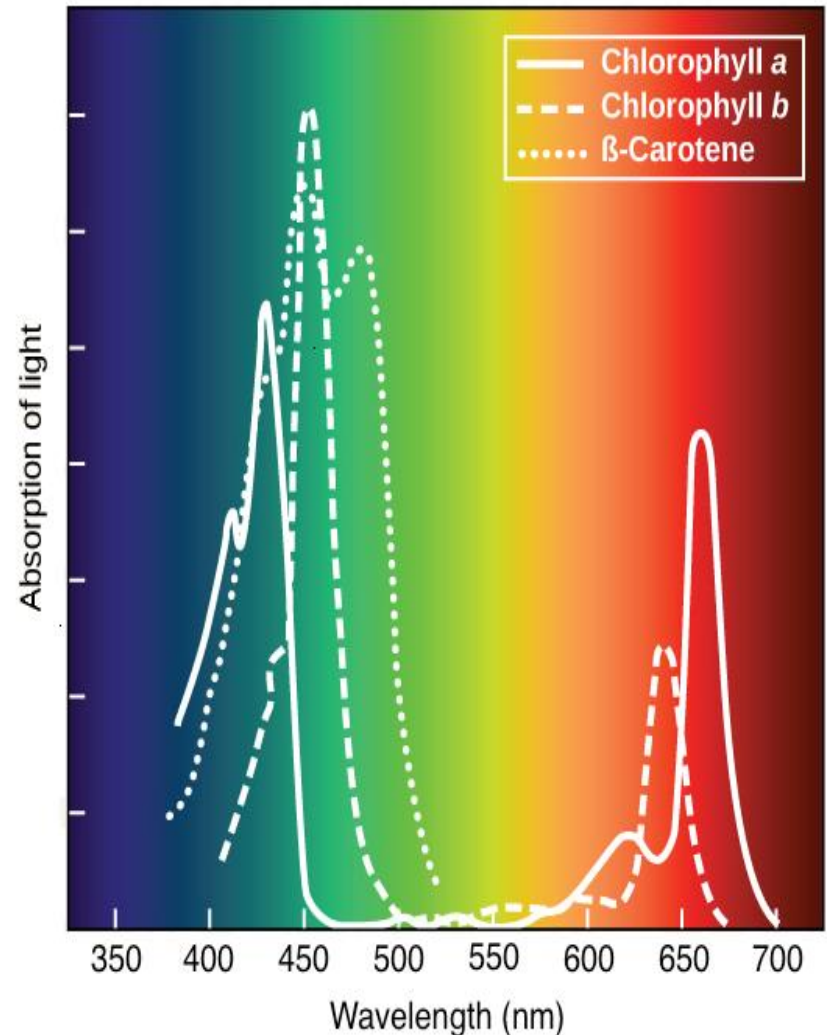
Photosynthesis (Chloroplast) pigments:

Chlorophyll a & b, Carotenoids
-absorb light of different energies

C-fixation (Chloroplast & Mitochondria)

- Photon Energy - splits CO_2 & H_2O
-“fixes” C into Carbs
- within Chloroplast
- $\text{C}_6\text{H}_{12}\text{O}_6$ of Photosynthesis used
for energy / growth / metabolism
- within Mitochondria
- Hydroponics:
- Blue/Green Spectra - leafy growth,
Red spectrum - flowering

Absorption Spectra of Pigments



Hydroponic BASIL

TYPES OF HYDROPONICS:

I. Sub-irrigation

- static solution, continuous-flow, passive sub-irrigation, **ebb and flow(flood and drain)**, deep water, rotary

II. Aeroponics, fogponics

II. Aquaponics (combined with fish, worms)

III. Top irrigation

- Run to waste
- Top-fed deep water



Rotary hydroponics

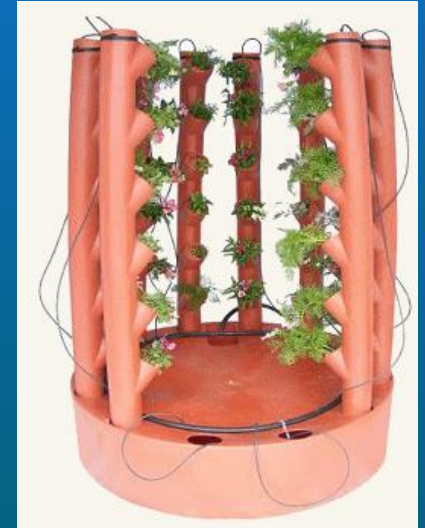
Hydroponic BASIL



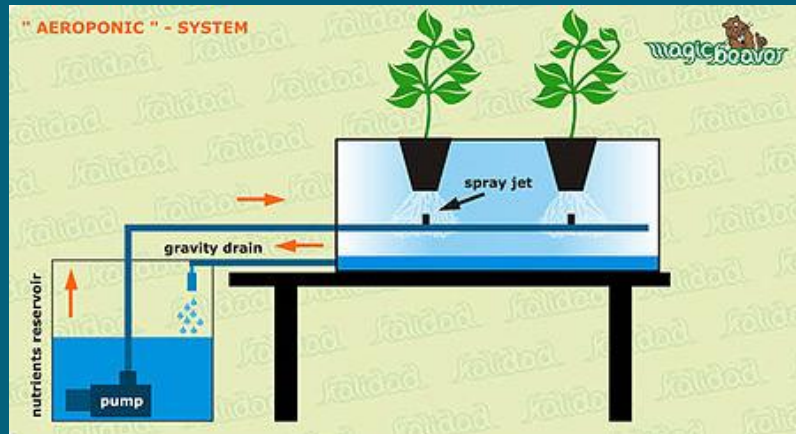
flood and drain



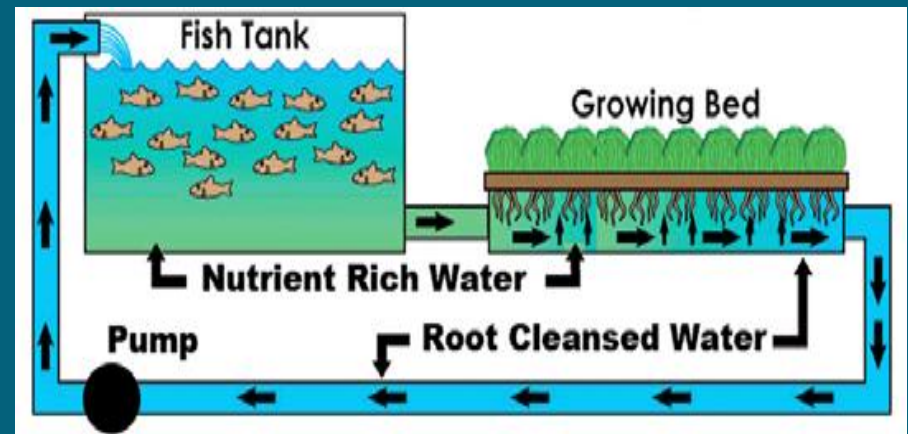
deep water



Hydroponic tower



aeroponics, fogponics



aquaponics

Hydroponic BASIL

LIGHTING:

- **POOR** Incandescent – don't use these
- **GOOD** **Fluorescents – T5 high output**
 - Economical, more efficient than T8 or T12, best for leafy growth (Basil!)
- **BETTER** High Intensity Discharge (HID)
 - Energy hungry, expensive, use in combination with T5s or LED
- **BETTER** **Light Emitting Diodes (LED) –**
 - Expensive upfront, inexpensive to run, red, blue or full spectrum
- **BEST** The Sun! –
 - Attached greenhouse, with supplemental lighting & insulation for winter growth



Hydroponic BASIL

SUBSTRATES:

- **Expanded clay pebbles**
- Growstones (recycled glass)
- Coir (coconut husks)
- **Composted organic material (peat)**
- Rice husks
- Perlite (volcanic glass)
- Vermiculite (silicate)
- Pumice
- Sand
- **Rock wool (mineral wool)**
- Packing peanuts



Hydroponic BASIL

I. HYDROPONIC SOLUTIONS: Chemical Based... Urea, Ammonium Nitrate

- **Essential Major nutrients** (besides CO₂ and H₂O)
Nitrogen (**N**), Phosphorus (**P**), Potassium (**K**)
- **Essential Minor nutrients and Micronutrients**:
Mg, S, Ca, SO₄, Cl, Fe, Cu, Mn, Zn, Mo, Bo, Na, Co
- No cation-exchange capacity, pH and nutrients change rapidly
- Selective absorption by plants, Nutrients can precipitate
- **Monitor pH closely**, buffer the solution
- CO₂ enrichment – fermentation , mushrooms, injection

Liebig's Law of the Minimum

- Growth = NOT total nutrients available, but **limiting** nutrients

Justus von Liebig (1800s German)

“father of fertilizer industry”

Hydroponic BASIL

II. HYDROPONIC SOLUTIONS: 'Organic' pre-mixed, can be more difficult to use

- ***Examples of Sources for Major nutrients:***
 - bloodmeal, bird guano - **N** source
 - bonemeal, bat guano – **P** source
 - kelp meal / liquid seaweed, guano – **K** source
- ***Examples of Sources for Micronutrients:***
 - wood ash, bone ash, bone meal - Ca, Mg, SO₄,
 - kelp meal/seaweed – various - Fe, Zn, Cu, Mn, Bo, Mo, Na
- Variable quality
- Particulate, can clog substrates and equipment
- Some organics can degrade to emit foul odors
- Unrefined pulverized minerals (Gypsum, Calcite, Glaucanite) meet National Organic Standards



Hydroponic BASIL

Botanicare Nutrients derived from:

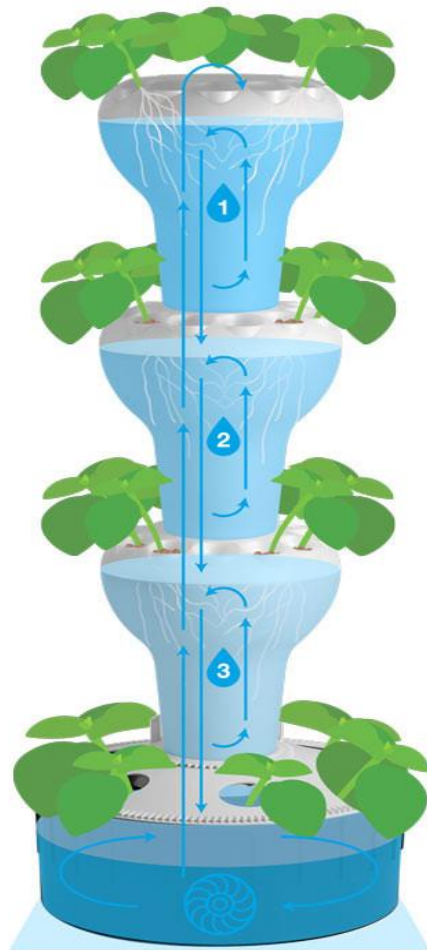
- Fish meal, Composted seabird guano, Kelp
- Rock Phosphate – $\text{Ca}_5(\text{PO}_4)_3\text{F}$ or $\text{Ca}_5(\text{PO}_4)_3\text{OH}$
(mined limestone or mudstone deposits)
- Potassium Carbonate – K_2CO_3
(mineral deposits or extracted wood ash, “potash”)
- Magnesium Carbonate – Mg CO_3
(dolomite or from seawater)
- Calcium Carbonate – CaCO_3
(coccolithophores, carbonate rock, “White Cliffs of Dover”)
- Humic Acid from Leonardite
oxidation product of lignite (“brown coal”) mining

Sustainable?...

- Organic and mineral sources, ...NOT urea or ammonia nitrate
- Small nutrient quantities ...(< 1/2 pint/yr for 80+ plants),
- Inexpensive electricity ...from clean hydroelectric

Hydroponic BASIL

Vertical Flood and Drain System (Diagram from www.foodyverticalgarden.com)



Ideal for Indoors

Clean, efficient system is ideal for rapid plant growth

Lots of Space

12 growing pockets per module (48 per tower – lots of options)



Removable Plant Pockets

Net cups hold growing medium and come out cleanly and easily

Responsible Materials

Both models are:
• BPA Free • Food Grade
• UV-Resistant



Optional Automatic Rotation

Motor-driven base rotates for optimum light exposure

Hydroponic BASIL



Grow Room / Basil Tower 2.0 (2017):

- Basil Tower, auto rotation, aquarium heater
- insulated / enclosed grow space
- 20,000 lumen T5 fluorescents (4) and blue LEDs
- *Botanicare* Nutrients
- Expanded clay pebbles & Rapid Rooter
- pH meter, conductivity meter
- CO₂ generator (mushroom),
- temperature / humidity datalogger

Hydroponic BASIL



- **Rapid Rooter** peat starter plugs
- Preferred **TDS**: 750-850 ppm, **pH** 5.1-6.0
- **Botanicare** nutrients: Grow: 3-2-4; Bloom: 2-3-5;
- CO₂ generation via sugar/yeast or **MyCO₂** mycelium generator (mushrooms!)

Hydroponic BASIL

Some (FEW) problems I've encountered:



Algal overgrowth, bacterial 'soup', apical meristem fungus,
poor germination - old seed

Hydroponic **ANYTHING ELSE!**

Some other plants that can be grown:

VEGETABLES

- **Arugula**
- Beans
- Brocoli
- Cabbage
- Cauliflower
- Chard
- Cucumbers
- Eggplant
- Endive
- **Kale**
- **Lettuce**
- Okra
- Pak choy
- Peppers
- Spinach
- **Strawberries**
- Tomatoes

HERBS

- **Basil**
- Chamomile
- Chives
- **Cilantro**
- Celery
- Echinacea
- Fennel
- Garlic chives
- Lavender
- Lemon grass
- Lemon balm
- Marjoram
- Parsley
- Rosemary
- Sage
- Savory
- Thyme

EDIBLE FLOWERS

- Calendula
- Carthamus
- Dianthus
- Marigolds
- **Nasturtiums**
- Pansies
- Viola

ORNAMENTALS

- Coleus
- Cosmos
- Delphinium
- Eucalyptus
- Hibiscus
- Impatiens
- Petunia
- Zinnia

Hydroponic BASIL

Some references:

- <https://www.nal.usda.gov/afsic/hydroponics>
- <http://www.hydroponics-simplified.com>
- <http://www.homehydrosystems.com/>
- <http://www.simplyhydro.com/hydrou.htm>
- <https://4hydroponics.com/>
- <https://foodyverticalgarden.com>
- Aquaponics?: check with www.dnr.alaska.gov & www.adfg.alaska.gov
- Books: *Hobby Hydroponics* by Dr. Howard M. Resh
 Hydroponics Basics by George Van Patten
 Hydroponics: Questions and Answers for Successful Growing by Howard Resh