Hydroponic Lettuce Production

Lettuce

- Lettuce (*Lactuca sativa*) belongs to Asteraceae family

- Lettuce is one of the major crops grown using hydroponics in the US and globally (50-60% of growers report producing lettuce)

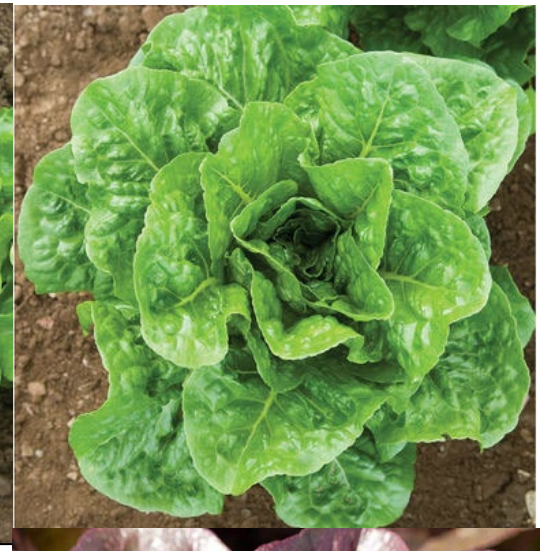
Different Groups of Lettuce

Butterhead

Leaf

Oakleaf

Romaine

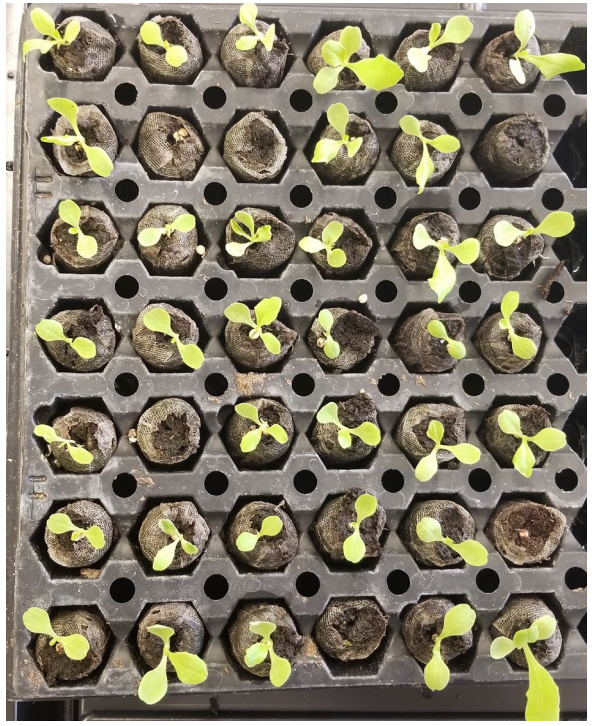


Seeds

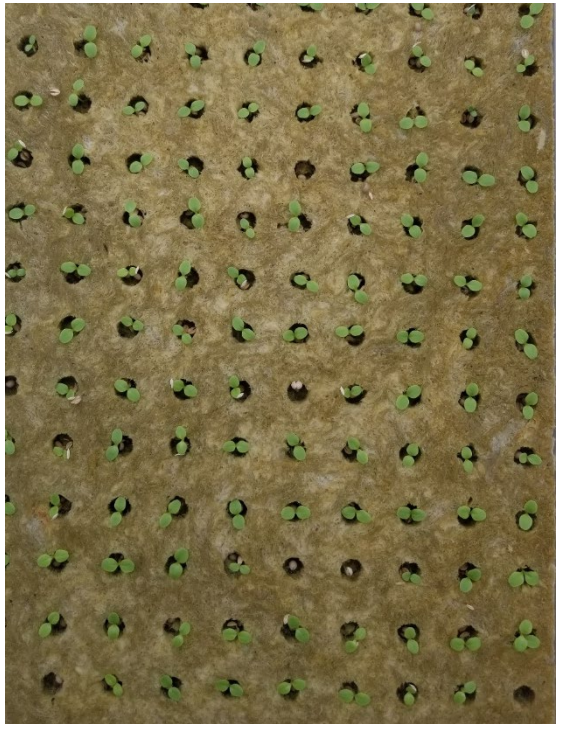
- Pelleted and normal seeds are available
- Pelleted seed is expensive but easy to plant and reduces wastage from excess sowing
- However, pelleted seed should be preferably used same year due to less shelf life.
- Continuous moisture should be available to break the pellet and wet the seed

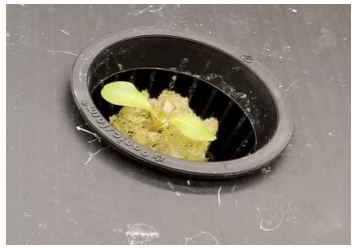
Sowing

Peat Pellets

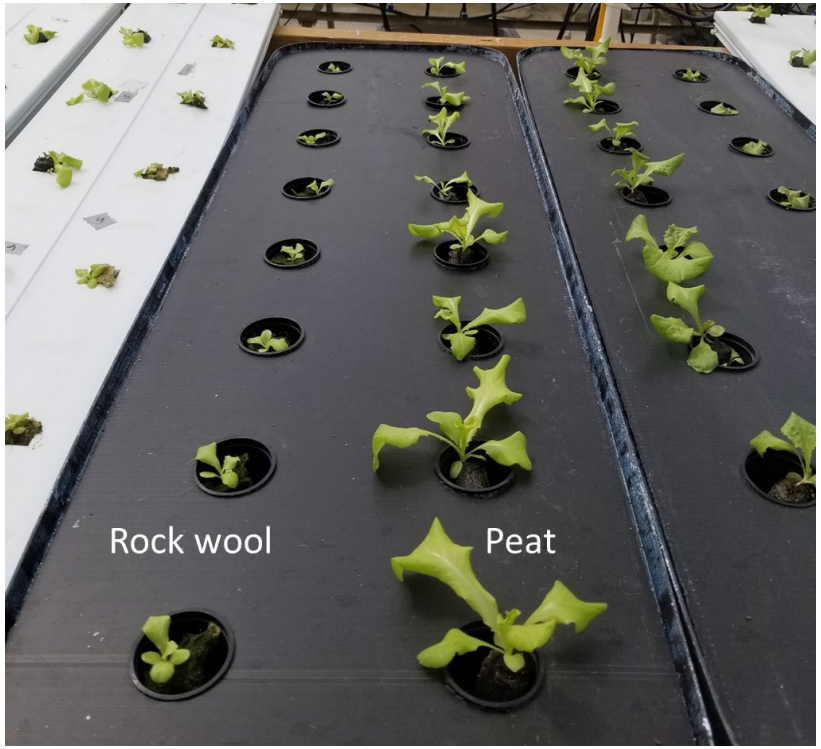


Rockwool cubes





Peat vs. Rockwool

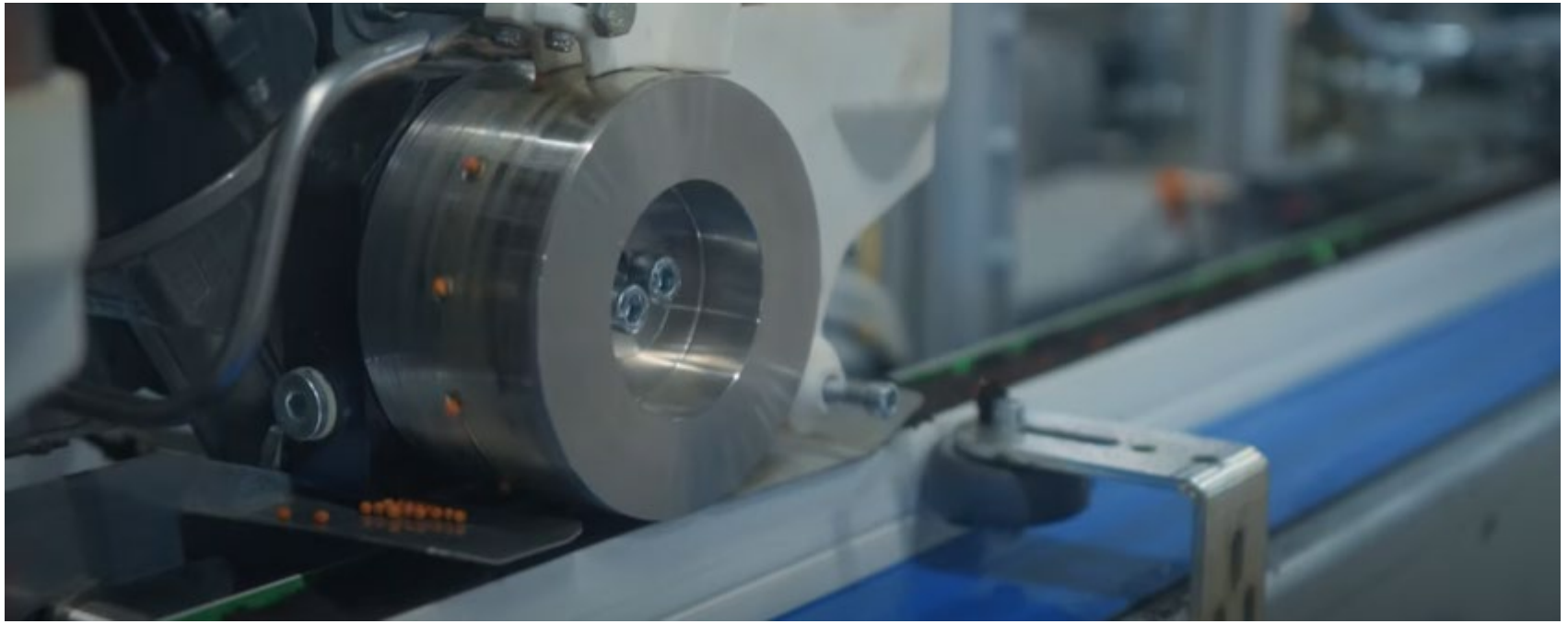


- Differences exist in water and nutrient retention between the two substrates
- Peat holds more water and nutrients than rockwool

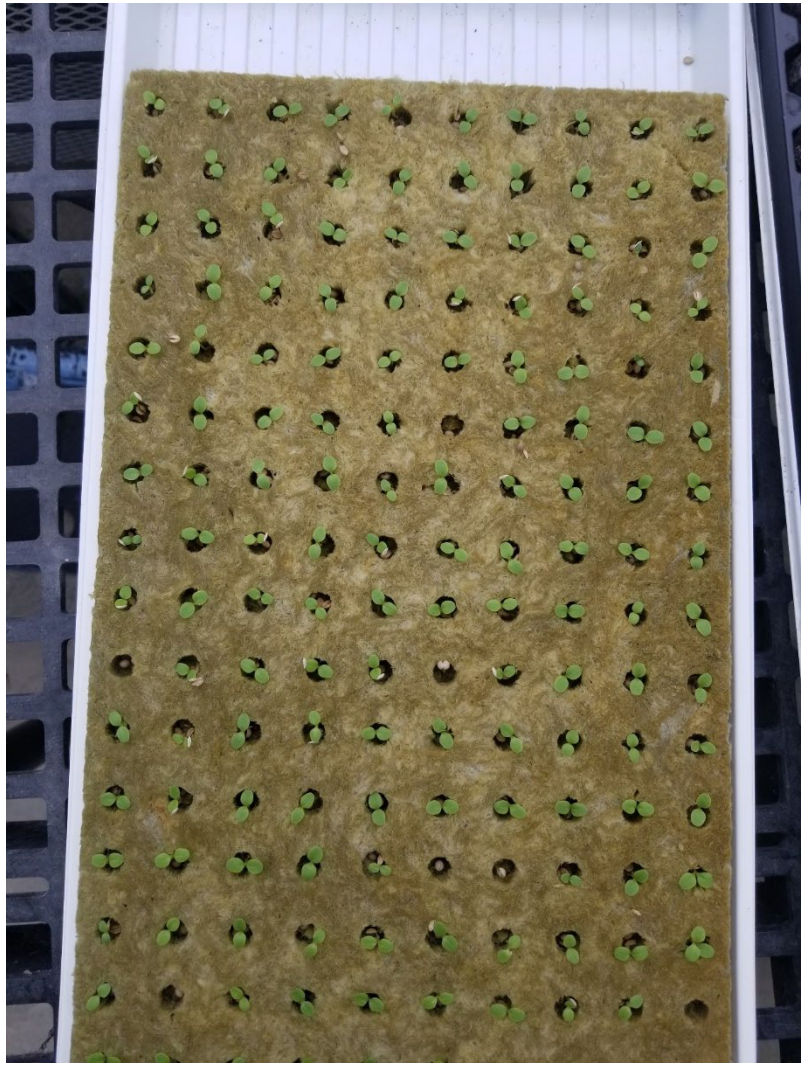
Sowing

Automated seeders are used in large-scale operations

Seed planted directly into peat-based substrate filled in channels



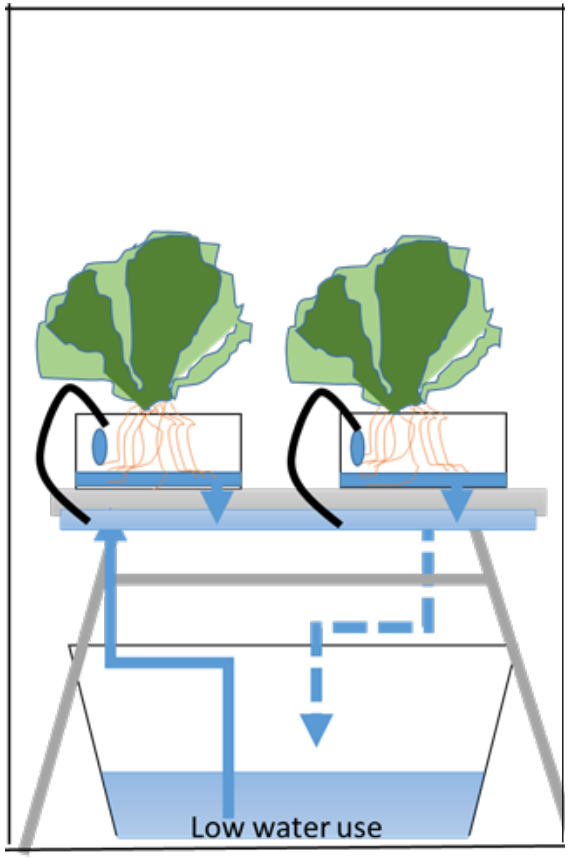
Germination Phase



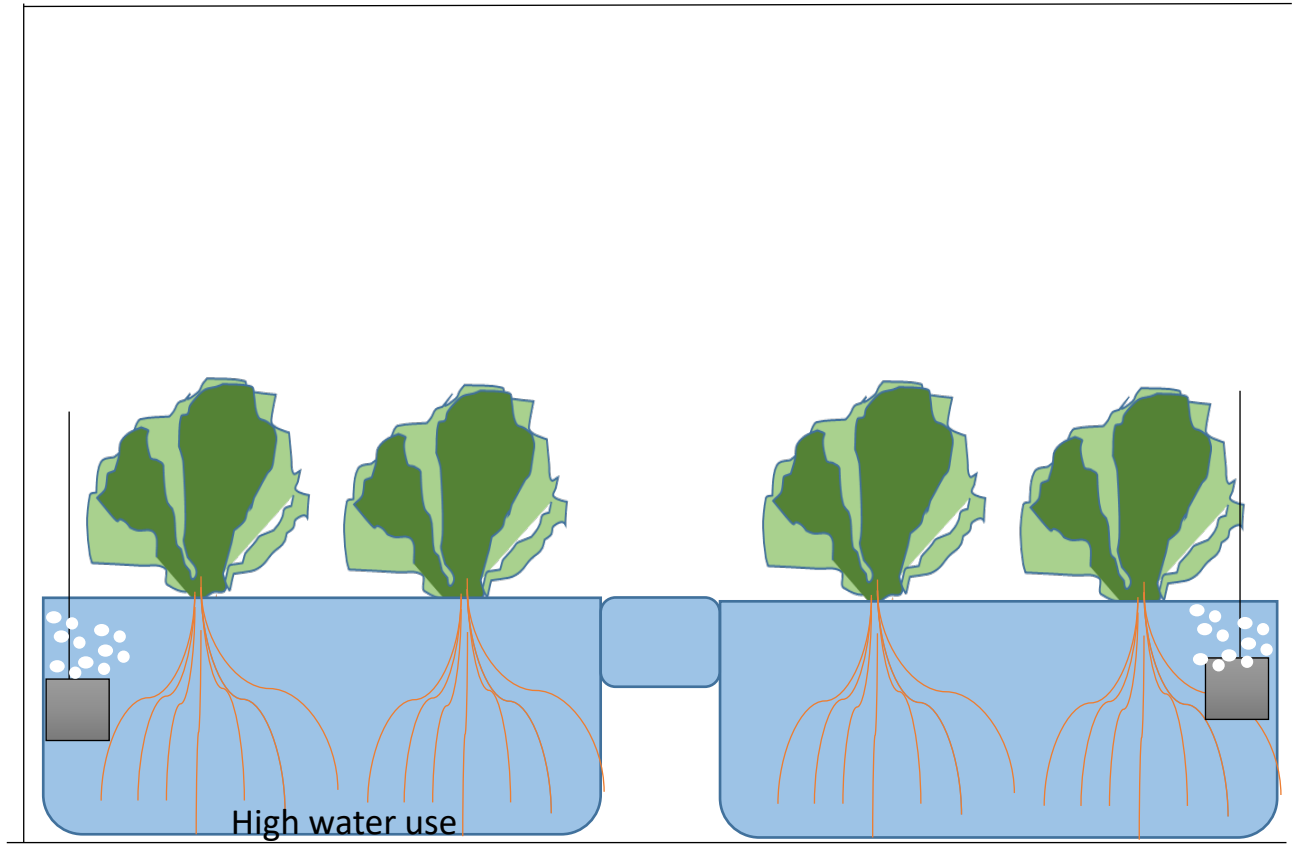
- Keep humidity high and plugs moist during the germination phase
- Use a dilute fertilizer solution (EC of 0.5 dS/m)
- Light intensity can be low (100 µmol/m^2/s) during the initial week
- Preferred germination temp ~ 70°F or 21°C
- Seedlings may need to be thinned, earlier thinning is preferred
- Transplant seedlings prior to leaf overlap

Production Systems

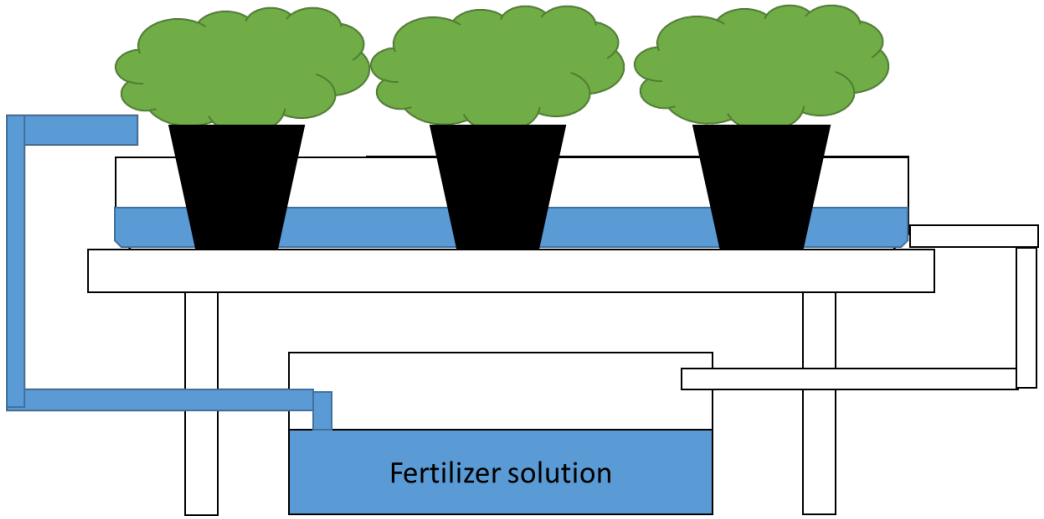
Nutrient Film Technique



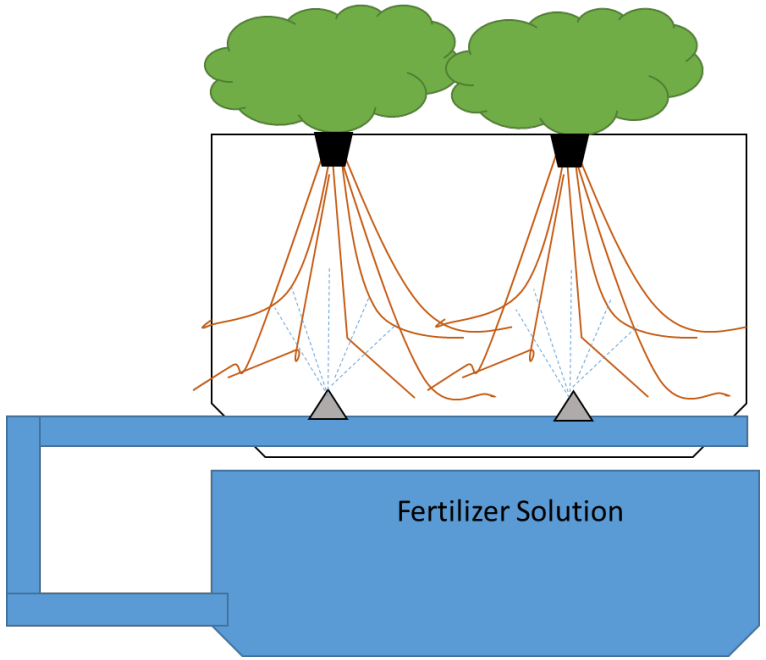
Deep Water Culture



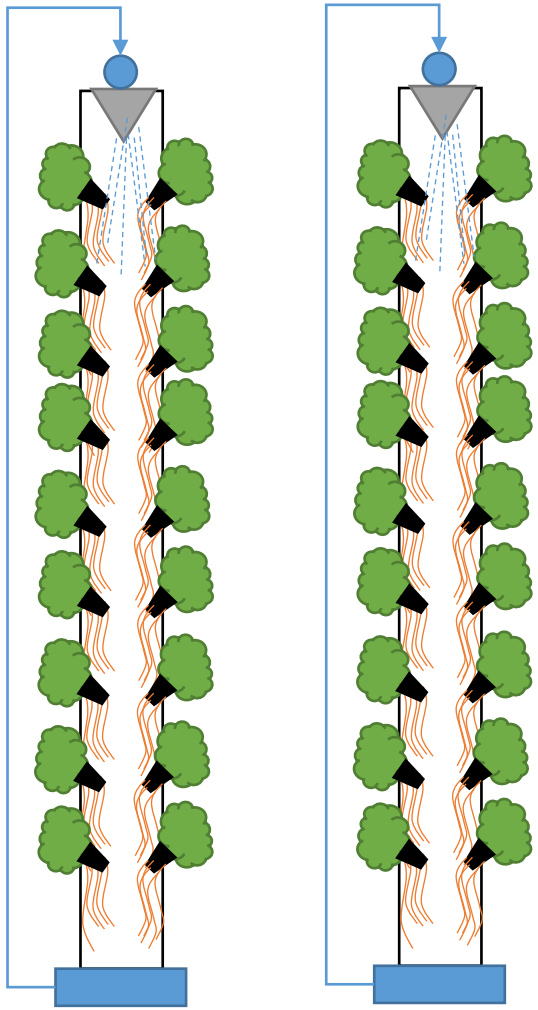
Flood-Drain Table

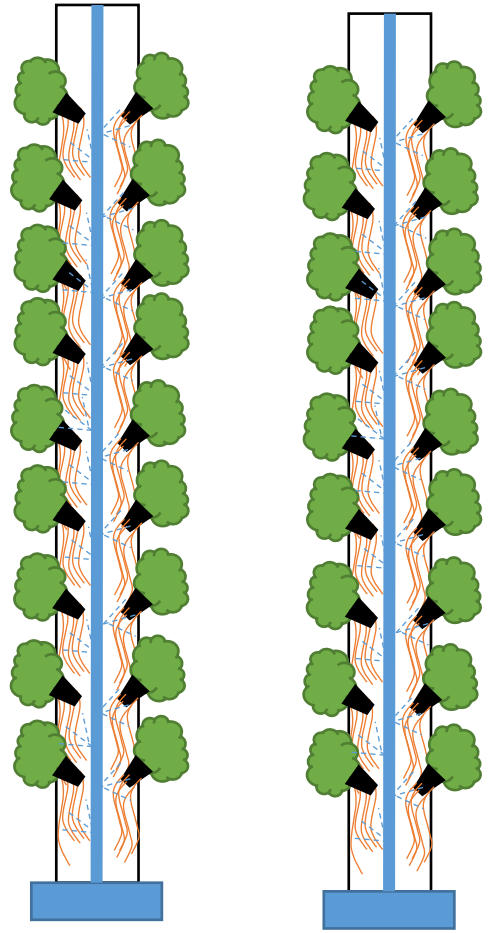


Aeroponics



Vertical Wall





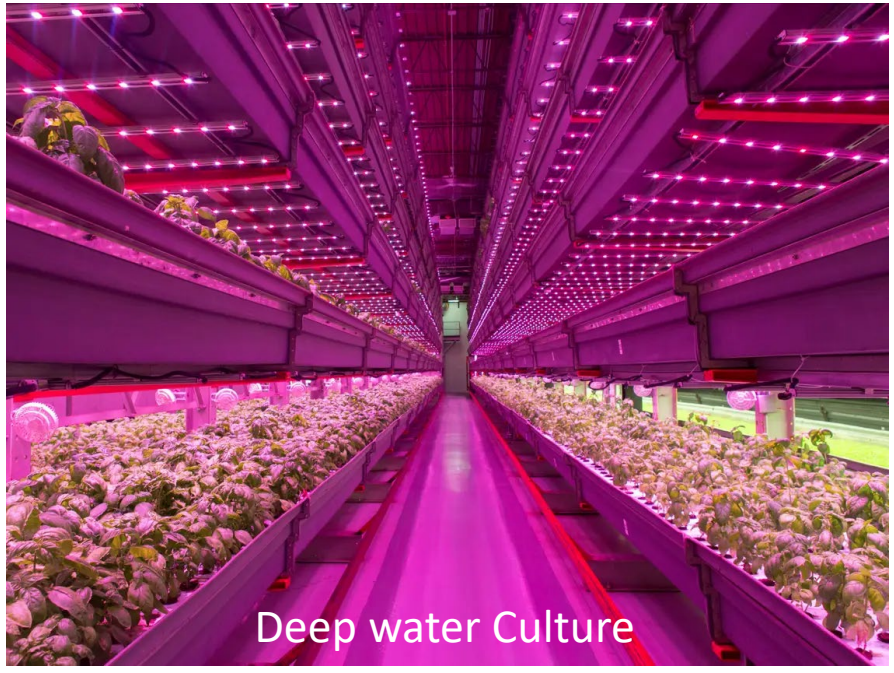
Production Systems

A production system houses plants
Nutrient solution is recycled through the production system
There are different types of commercially available production systems

Nutrient Film Technique (NFT)

Deep Water Culture (DWC)

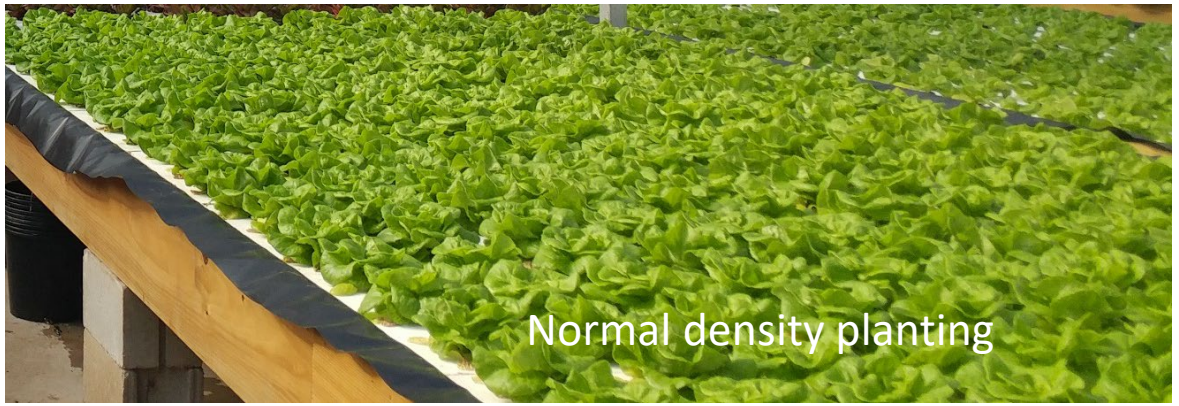

Vertical Wall

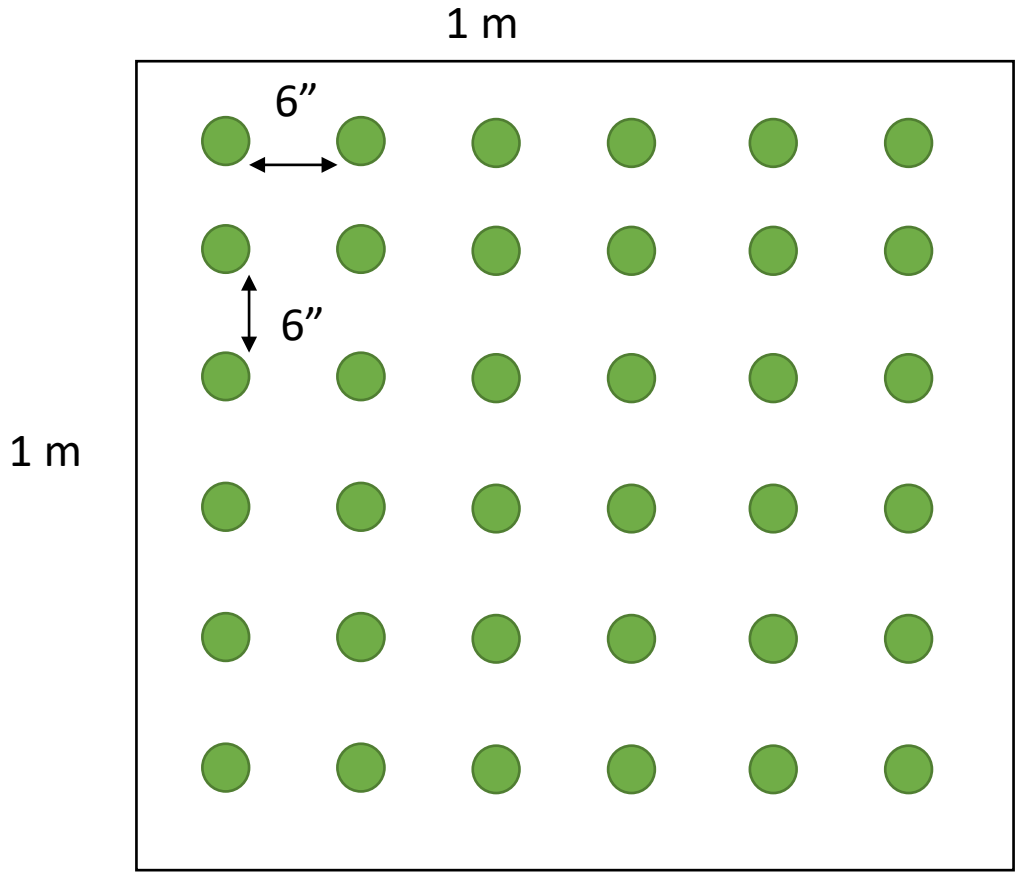

Deep water Culture


LED LIGHTING
LEAFY GREENS
AEROPONIC MIST
CLOTH MEDIUM
SOLUTION CHAMBER
Aeroponics


Nutrient Film Technique

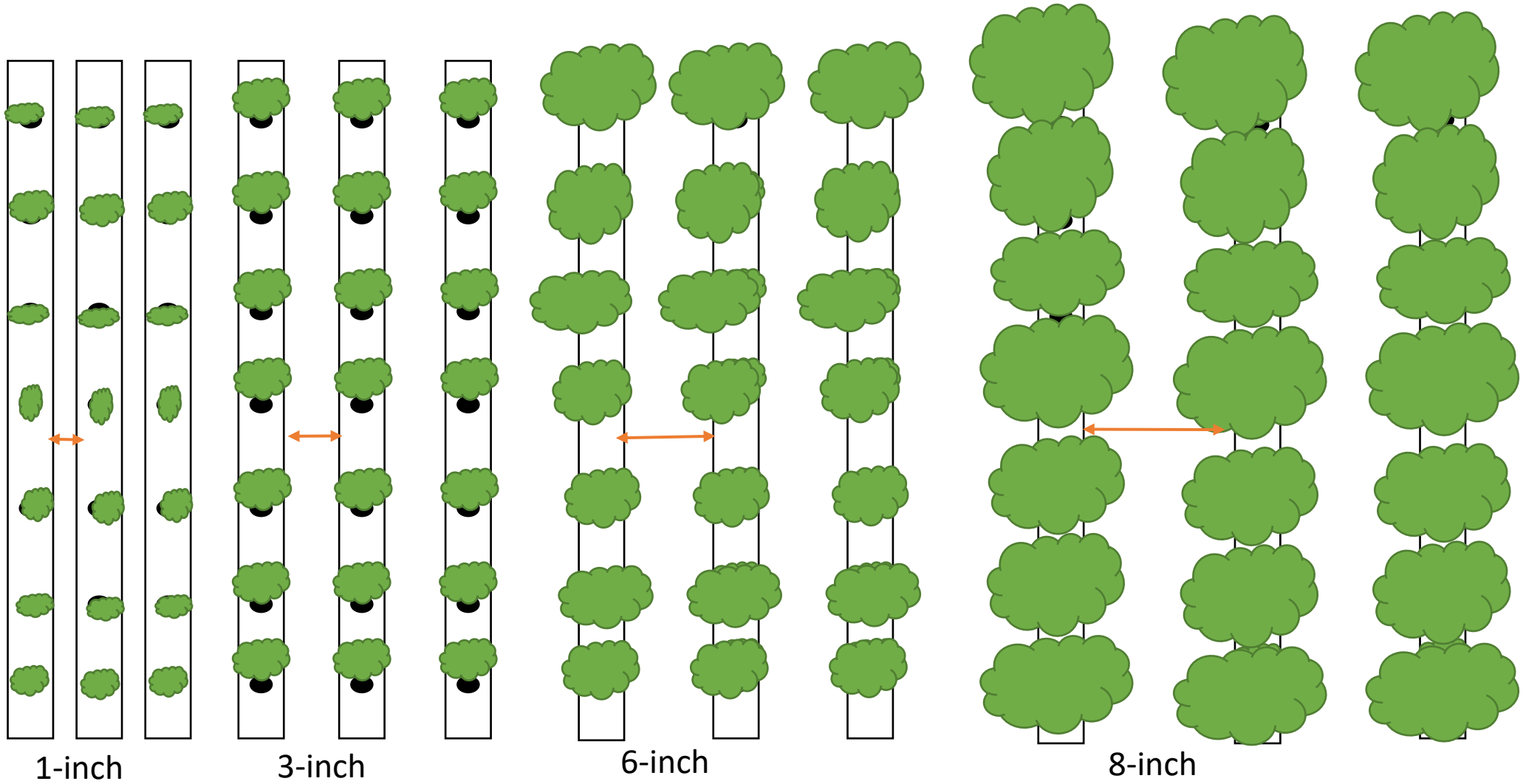
Spacing (33-36 plants/m^2)





Closer spacing reduces individual plant size

Spacing: Sliding NFT Benches



Nutrient requirement

- Concentrates of calcium based nutrients are kept separate from sulfates and phosphates to avoid chemical reactions
- Lettuce requires a nitrogen concentration of 75 to 100 ppm. Nutrient calculators are provided by companies to do complex calculations and match the supply of N, P and K from different compounds
- Weeks 3 and 4 are critical; better to discard recycling solution in the large reservoir after two weeks of use
- pH affects nutrient solubility; maintain a pH of 5.5 to 6.0

Tank A

Calcium Nitrate
DTPA-Iron

Tank C

Acid

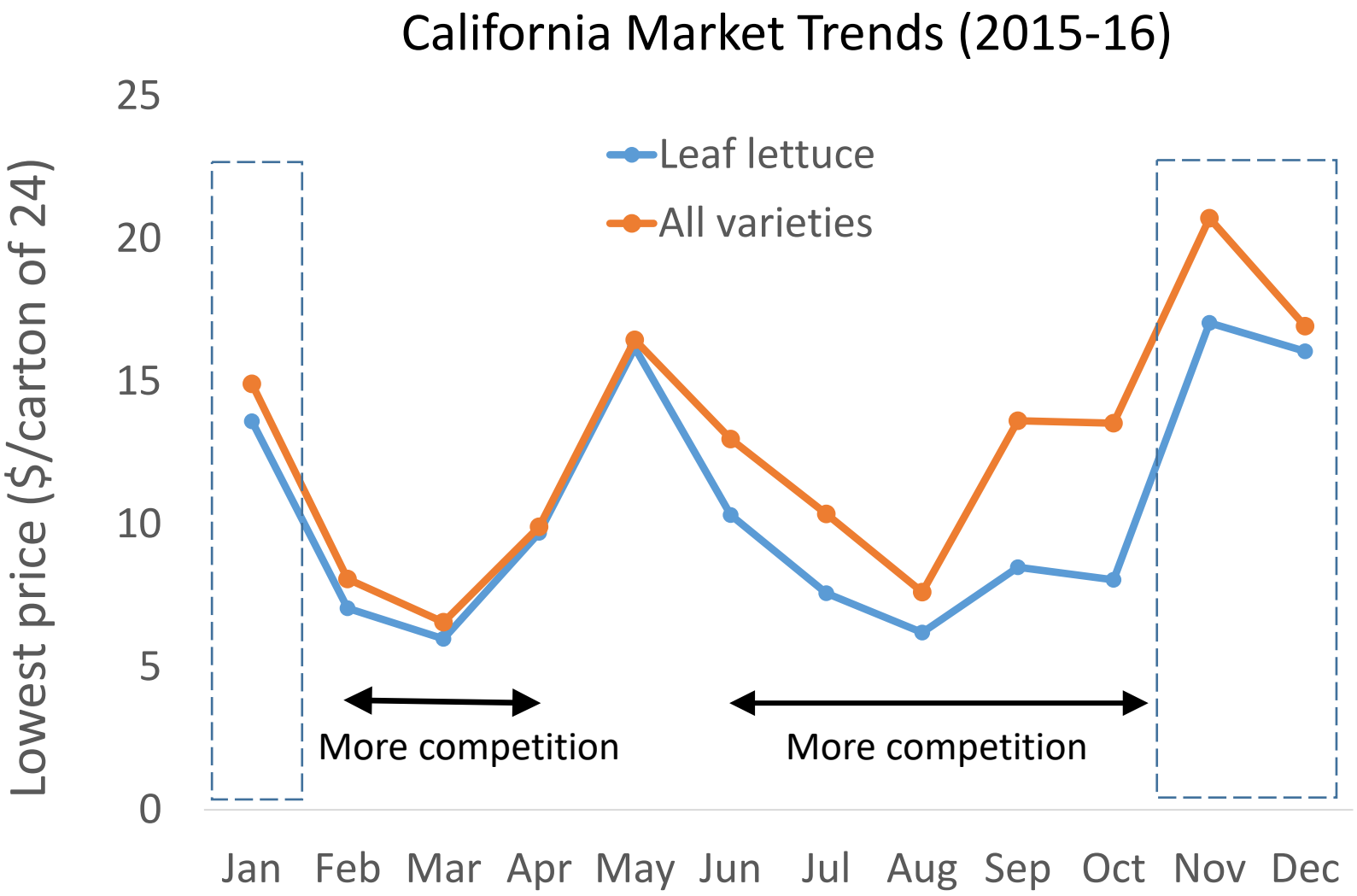
Tank B

- Mono Potassium Phosphate
- Potassium Nitrate
  Potassium Sulfate
- Magnesium Sulfate
- Zinc-, Manganese-, and Copper sulfates
- Boric acid
- Sodium Molybdate

Source: CropKing

Hydroponically-grown lettuce is sensitive to short periods of drought

Prices are higher in winter



USDA Agric. Marketing Service

Optimum greenhouse temperature

- Optimal temperature for lettuce is approximately 70°F
- Warm temperatures cause excess growth/ bolting while cold temperature slow growth

Greenhouse Air Temperature

60 °F

70 °F

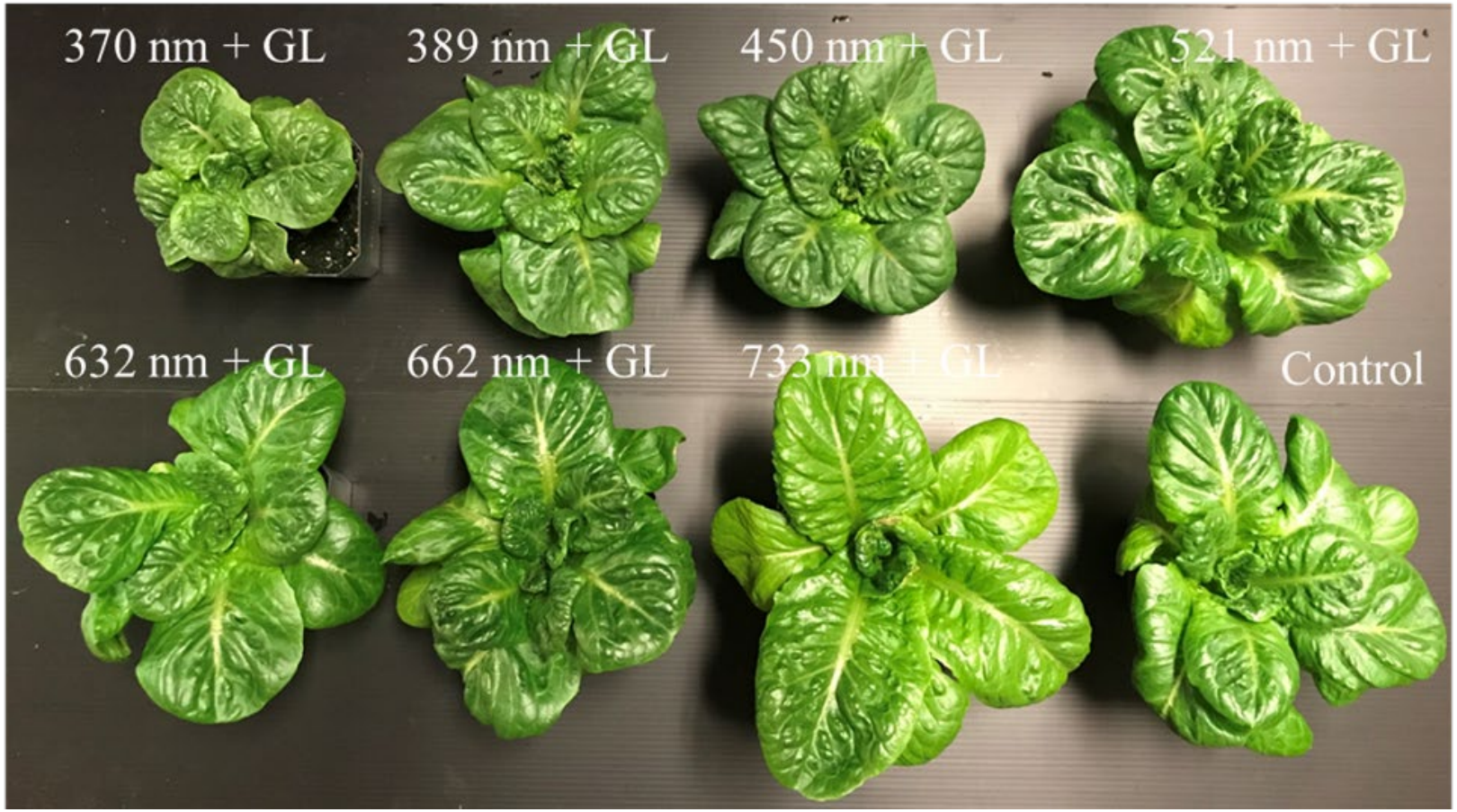
80 °F

Temperature control in greenhouses and indoor farms

Greenhouses	Indoor Farms
Heating costs can be high due to increased heat losses (remember heat loss equation!)	LED inefficiencies release a lot of heat inside the structure. Heating costs are relatively less
Insulation can vary by glazing materials	Superior insulation options
Temperature control can be challenging, especially at nighttime	Better temperature control
Humidity is not a concern due to ventilation options	Humidity build up is a concern
Cooling is not a major issue except in some summer months	Generally, cooling (regardless of season) is important

Optimal light intensity

Light quality can be manipulated in indoor farms to obtain favorable growth and increase light interception



Light quality can be manipulated in indoor farms to enhance nutritional quality

Figure. Representative green romaine lettuce plants from different light treatments. (a). Continuous low blue (b). Low to high blue (c). Continuous high blue or H, and (d). High to low blue or HL.

Treatment	antho	beta-car
	$\Delta OD \cdot g^{-1}$	$mg \cdot 100\ g^{-1}$
a	0.000	4.08
b	0.002	5.54
c	0.018	4.89
d	0.014	3.74

Nutrient Deficiencies

Tip burn is a common nutrient deficiency in lettuce due to calcium. This is mainly caused by high temperature resulting in excess growth and poor air flow increasing relative humidity inside the greenhouse

Sometimes, failure of automated dosing system to accurately predict nutrient concentration can cause nutrient deficiencies (e.g. improper EC/ pH sensor calibration)

Insect and Disease Management

Prevention is better than control for insects and diseases

- Clean surfaces
- Monitoring and early detection
- Minimize secondary hosts
- Good air flow
- Throw away old solution

- Running 2% bleach solution through hydroponic system for a day followed by rinsing with plain water for a day between cycles is an effective way to control root borne diseases

Aphids

Pythium

Harvesting

- Lettuce can be harvested in 25 to 35 days after transplanting
- Cut whole-heads or leaves and separate from the roots
- Process minimally after harvest
- Ensure that lettuce is not contaminated with human pathogens from water (while washing), machines, and farm workers
- Store lettuce at 40 °F if it is not intended for fresh market