An Introduction to Hydroponic Production

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What we will be talking about today:

- What is hydroponic production?
- Advantages vs Disadvantages
- Common Crops Grown
- Hydroponic Systems
- Nutrient Management

What is Hydroponic Production?

- The growing of plants in a liquid nutrient solution with or without the use of artificial media
- Commonly used media includes
  - Coir
  - Perlite
  - Vermiculite
  - Rockwool

Hydroponic System Advantages

- Ease of use in unsuitable locations
- Complete control of nutrient content and pH
- Water and nutrients are recycled
- No weeding or cultivation
- No need for crop rotation

Hydroponic System Disadvantages

- Initial setup and operating costs
- Skill and knowledge are needed to operate the systems properly
- Diseases like *Fusarium* and *Verticillium* can spread quickly through the system

Common Crops

- Leafy greens
  - Lettuce
  - Kale
  - Arugula
  - Swiss chard
  - Pak choi
  - Spinach
  - Mustard
  - Baby leaf greens
- Herbs
  - Basil
  - Cilantro
  - Parsley
  - Chives
  - Dill
  - Mint

Common Crops

- Cucumbers
- Eggplant
- Peppers
- Tomatoes
  - All are grown in aggregate systems with wire support

Ex. Lettuce Seedling Culture

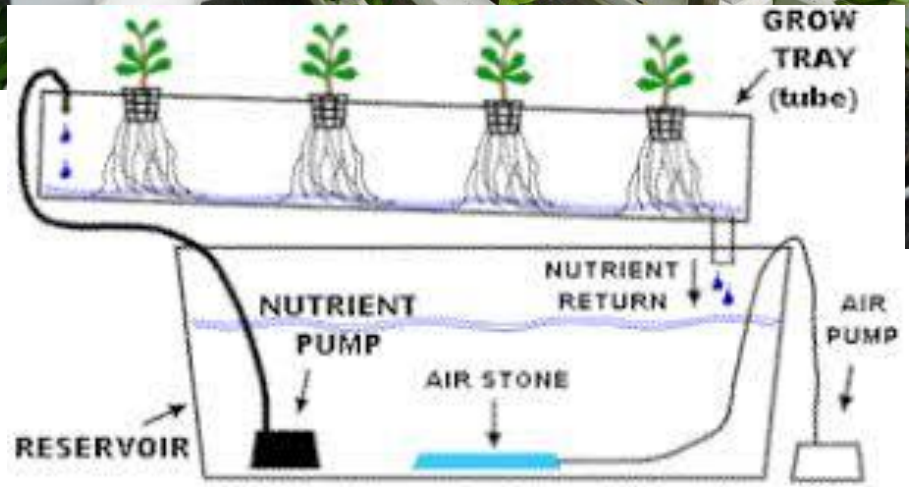
- 1 inch cubes (Rockwool, Oasis, Jiffy, etc.)
- Temperature 68 – 72 F
- Irrigate on ebb and flood trays (or by hand)
- Transplant when 3-4 true leaves (10 –21 d)

Seedlings planted in rafts

Nutrient Film Technique

- Uses a long gutter or trough to hold the plants as they grow
- Nutrient solution is piped in at the top of the gutter, flows down and then drains at the bottom of the channel into the reservoir tank (a closed system)
- The reservoir tank is usually aerated to increase the oxygen levels available to the plants
- 4” wide x 1.5” deep x 12 ft long channels

Nutrient Film Technique



Nutrient Film Technique

Deep Flow Technique

- Seedlings are inserted into a raft generally made of styrofoam
- Rafts can support a single plant or multiple plants depending on the crop
- Rafts float directly in the nutrient solution
- Roots will grow into the solution
- Aeration of the nutrient solution is required

Deep Flow Technique

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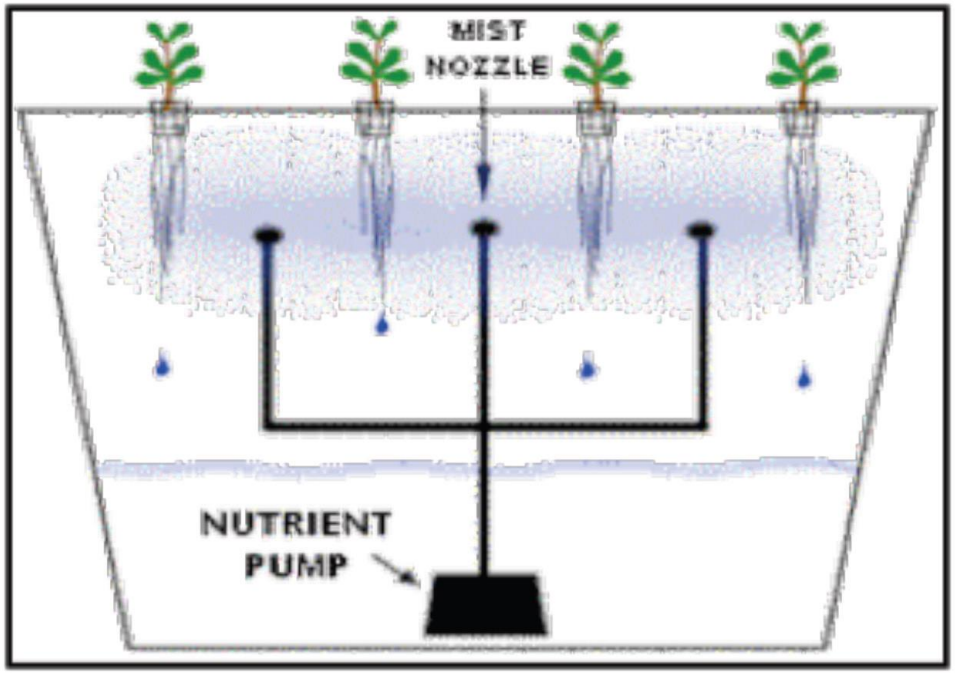
Aeroponic System

- Short cycle timer runs a nutrient pump
  - Few seconds every couple of minutes
- Root bathed in mist which oxygenates when in contact with air

Aeroponic Technique



Aggregate Hydroponic Systems

- Container Culture
  - Containers hold the soilless aggregate medium (such as perlite) in which the plants grow
  - buckets, pots, or grow-bags
- Slab Culture
  - Plants are grown in long, flat slabs of media wrapped in plastic
  - Commonly filled with rockwool and/or coco coir
  - Slab dimensions vary by crop and conditions but typically measure a couple inches in depth, a foot or so in width, by a few feet in length

Aggregate Hydroponic Systems

Dutch Bucket Production

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Nutrient Management

- Nutrient Film Technique
  - Typically small volume water per plant
  - Nutrient imbalances can occur relatively quickly
  - Drain and replace nutrients every 10-14 days
  - Or laboratory analysis adjust
- Pond/Deep water culture
  - Larger volume of water
  - Start with reverse osmosis water
  - Use for several crop cycles
  - Laboratory analysis every 1-2 weeks and adjust

pH/EC tested and adjusted at least daily (pH 5.6 to 6) (EC 1.5 to 3 dS m^{-1})

Table 1. Major element and micronutrient ionic forms and normal concentration range found in most nutrient solutions (Jones, 2005).

Element	*Ionic Form*	*Concentration Range mg/L, ppm*
Major Elements		
Nitrogen (N)	NO_3^-, NH_4^+	100 to 200
Phosphorus (P)	HPO_4^{2-}, $H_2PO_4^-$	30 to 15
Potassium (K)	K^+	100 to 200
Calcium (Ca)	Ca^{2+}	200 to 300
Magnesium (Mg)	Mg^{2+}	30 to 80
Sulfur (S)	SO_4^{2-}	70 to 150
Micronutrients		
Boron (B)	BO_3^{3-}	0.03
Chlorine (Cl)	Cl^-	—
Copper (Cu)	Cu^{2+}	0.01 to 0.10
Iron (Fe)	Fe^{2+}, Fe^{3+}	2 to 12
Manganese (Mn)	Mn^{2+}	0.5 to 2.0
Molybdenum (Mo)	$Mo0_4^-$	0.05
Zinc (Zn)	Zn^{2+}	0.05 to 0.50

Business and Marketing Information

CornellCALS
College of Agriculture and Life Sciences

Controlled Environment Agriculture

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Business planning tools for CEA

In 2016 and 2017 the Cornell Controlled Environment Agriculture (CEA) group and colleagues in the Dyson School and the Cornell Institute for Food Systems conducted studies and developed materials on CEA business and marketing with support from the U.S. Department of Agricultural Marketing Service.

CEA Background
By Neil Mattson

- Slides: Intro to CEA, common crops, systems, and market trends
- Slides: Ten things you should know when starting a CEA business

Interactive Spreadsheets for Greenhouse Lettuce and Tomato Production
By Irin Nishi, Miguel Gomez, and Neil Mattson

- Presentation with an overview of the spreadsheets and key findings
- Lettuce cost accounting tool
- Tomato 8 month production cost accounting tool
- Tomato year-round production cost accounting tool

Public-private partnership led by Cornell and Rensselaer Polytechnic Institute to integrate advanced energy-efficient LED lighting with improved environmental controls for more efficient and sustainable greenhouse production.

CEA Viability in Metro Areas

New NSF-funded project.

Cornell Greenhouse Horticulture

Infographic:

How indoor ag is a boon to foodies.

CEA can help meet

Presentation References

- Intro. to CEA, common crops, systems, and market trends – Cornell CALS
- Productions systems for leafy greens and herbs – Cornell CALS
- Hydroponic Lettuce – University of Kentucky
- Hydroponics – Oklahoma State University
- Growing Interest in Hydroponics and Aquaponics in Virginia – Virginia State University

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