

This material is based upon work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under award number 2019-38640-29879 through the North Central Region SARE program under project number YENC20-145. USDA is an equal opportunity employer and service provider. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.

3 Production steps

Juan C. Cabrera

Field Specialist in Horticulture

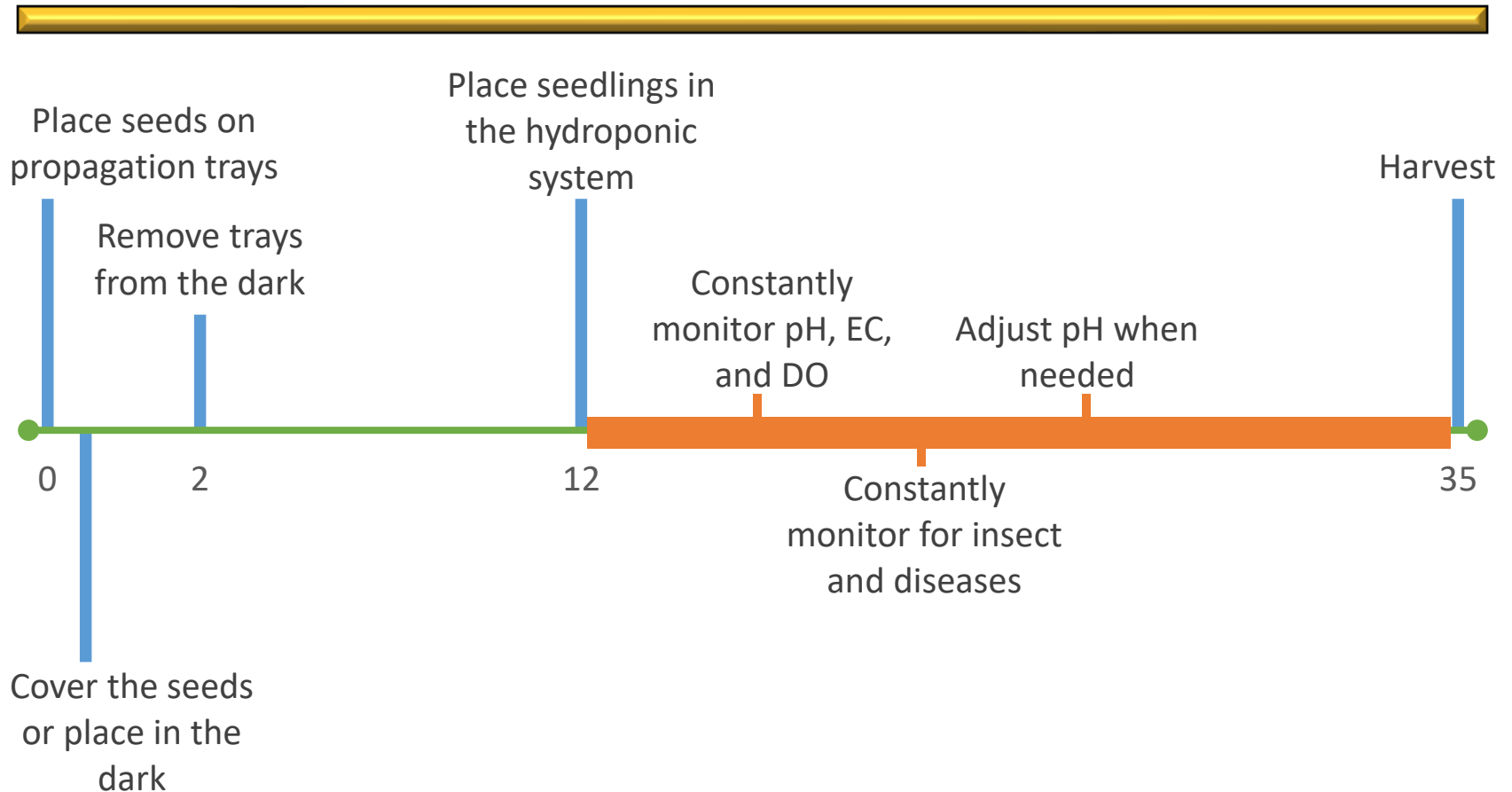
Email: jcabrera-garcia@missouri.edu

Phone: (573)-686-8064

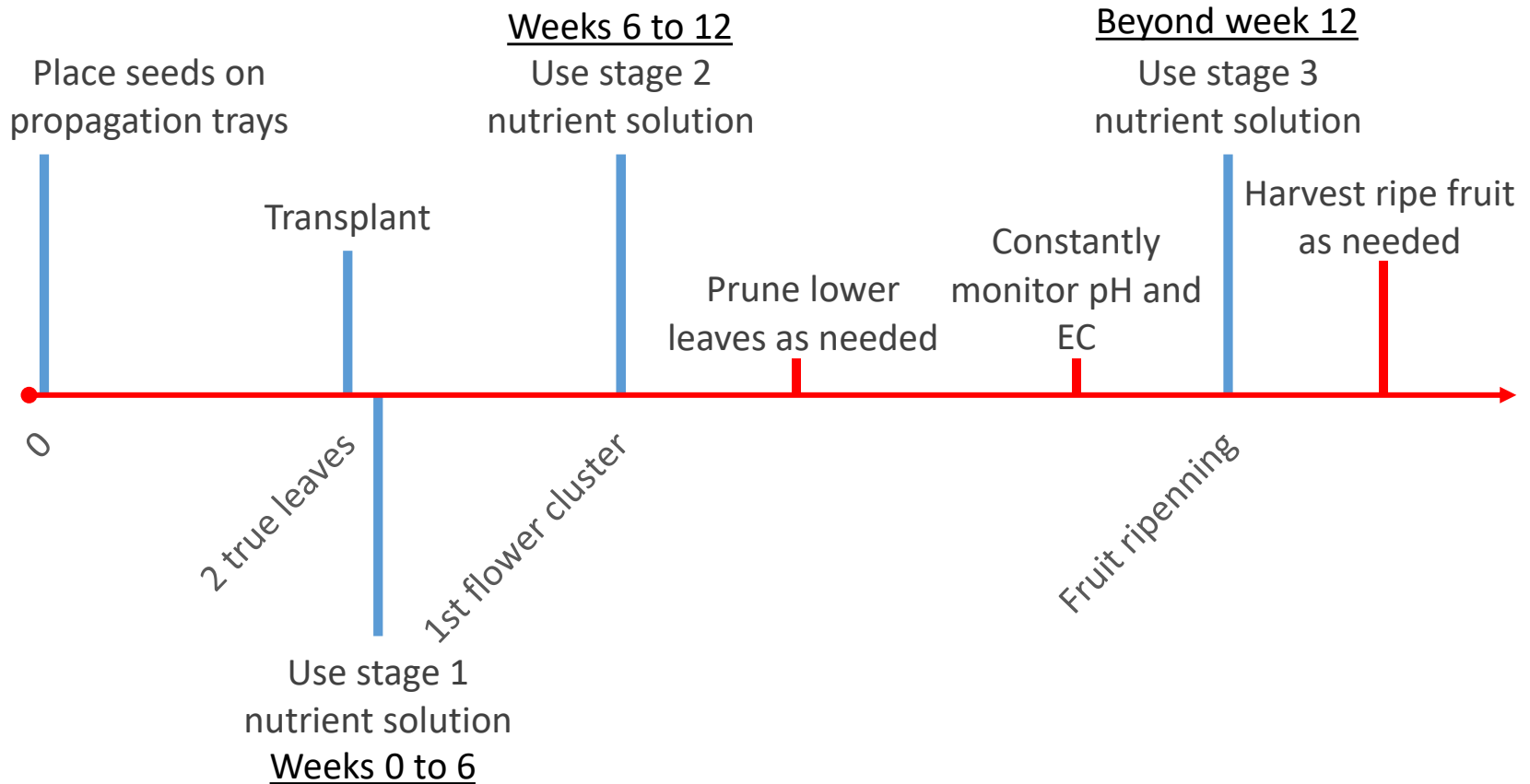
Topics

1. Plant production timelines: lettuce and tomatoes
2. Seedling production
3. Making nutrient solutions
4. Hydroponic crop production Leafy greens and vine crops
 - Taking care of lettuce crops
 - Taking care of tomato crops
5. Monitoring nutrient solutions and pests

Hydroponic lettuce production timeline



Hydroponic tomato production timeline



Topics

1. Plant production timelines: lettuce and tomatoes
2. Seedling production
3. Making nutrient solutions
4. Hydroponic crop production Leafy greens and vine crops
 - Taking care of lettuce crops
 - Taking care of tomato crops
5. Monitoring nutrient solutions and pests

Media for seedling production

Rockwool



Compressed peat or coconut coir pellets



Synthetic materials



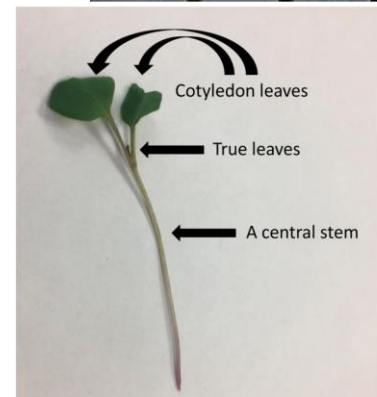
Foto: Grodan.com

University of Missouri



Seedling production

1. Saturate the media with water (no fertilizers)
2. Place the seeds on the media
3. Cover the seeds for 24-48 hours (or place in a dark room)
4. Remove the cover and place seeds under light and keep them moist using a 75 ppm N nutrient solution
5. Seedlings will be ready when the first pair of true leaves are **fully expanded**
6. Place the seedling in the system on the net pots



Seedling production



Seedling production in the Netherlands



System prep before transplant

- Clean debris from previous crop
- Inspect system for leaks and broken parts
- Make sure you have all meters and materials in stock
 - Fertilizers
 - Acid and base (adjust pH)
 - Conductivity and pH meters (with calibrating solutions)
 - Air pumps with air diffusers (DWC system)
- Mix fertilizer with water then adjust pH

Topics

1. Plant production timelines: lettuce and tomatoes
2. Seedling production
3. Making nutrient solutions
4. Hydroponic crop production Leafy greens and vine crops
 - Taking care of lettuce crops
 - Taking care of tomato crops
5. Monitoring nutrient solutions and pests

Lettuce

- For every 10 gallons add
 - 1.34 oz (40 grams) of 5-12-26 fertilizer
 - 0.87 oz (25 grams) of 15.5-0-0 fertilizer
- Dilute the fertilizers separately each in 5 gallons then combine the dissolved fertilizers
- Measure pH and EC
- Adjust the pH between 5.5 to 6.0

Element	Required ppm	Provided by fertilizers
Total N	150	150.75
P	31	110
K	210	260
Ca	90	123.5
Mg	24	31
S	0	40
B	0.16	0.5
Cu	0.02	0.15
Fe	1	3
Mn	0.25	0.5
Mo	0.02	0.1
Zn	0.13	0.15

Tomato Stage 1

- Use until you see the first cluster of flowers (approx. 6 weeks)
- For every 10 gallons add:
 - 0.8 oz (23 grams) of 5-12-26
 - 1 oz (29 grams) of 15.5-0-0
 - 0.4 oz (11 grams) of Epsom salts
- Dilute fertilizers separately
- Measure pH and EC
- Adjust pH

Element	Required ppm	Provided by fertilizers
Total N	145	150
P	47	72
K	145	156
Ca	144	147
Mg	60	65
S	10	90
B	0.4	0.30
Cu	0.05	0.09
Fe	2	2
Mn	0.55	0.30
Mo	0.05	0.11
Zn	0.33	0.09
K:N ratio	1.0	1.04

Tomato Stage 2

- Use until you see the fourth cluster of flowers (weeks 6 to 12)
- For every 10 gallons add:
 - 1.5 oz (43 grams) of 5-12-26
 - 1.2 oz (34 grams) of 15.5-0-0
- Dilute fertilizers separately
- Measure pH and EC
- Adjust pH

Element	Required ppm	Provided by fertilizers
Total N	195	195
P	47	137
K	300	300
Ca	160	168
Mg	60	69
S	10	98
B	0.4	0.58
Cu	0.05	0.17
Fe	2	3.5
Mn	0.55	0.58
Mo	0.05	0.22
Zn	0.33	0.17
K:N ratio	1.54	1.54



Tomato Stage 3

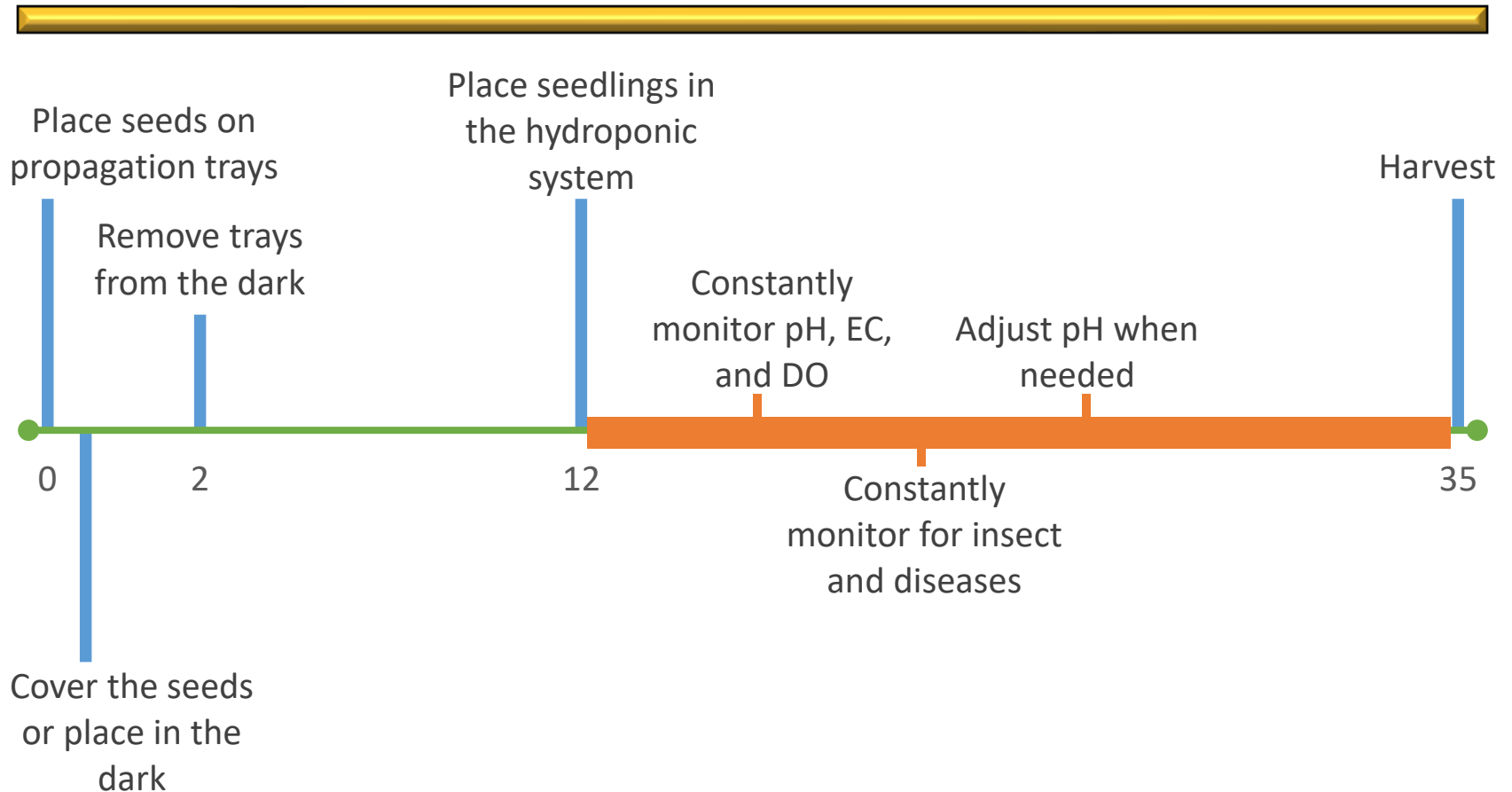
- Use when you see the fruits ripening (plants older than 12 weeks)
- For every 10 gallons add:
 - 2 oz (57 grams) of 5-12-26
 - 1.4 oz (39 grams) of 15.5-0-0
- Dilute fertilizers separately
- Measure pH and EC
- Adjust pH

Element	Required ppm	Provided by fertilizers
Total N	205	240
P	47	186
K	350	403
Ca	200	200
Mg	60	93
S	10	132
B	0.4	0.8
Cu	0.05	0.2
Fe	2	4.7
Mn	0.55	0.8
Mo	0.05	0.3
Zn	0.33	0.2
K:N ratio	1.7	1.68

Topics

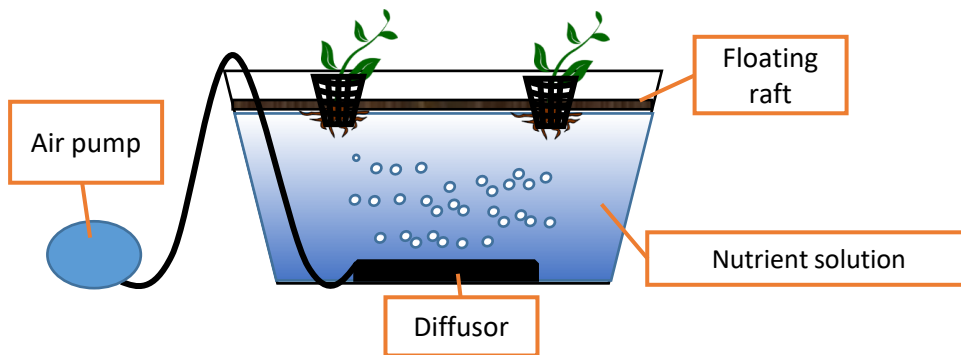
1. Plant production timelines: lettuce and tomatoes
2. Seedling production
3. Making nutrient solutions
4. Hydroponic crop production Leafy greens and vine crops
 - Taking care of lettuce crops
 - Taking care of tomato crops
5. Monitoring nutrient solutions and pests

Hydroponic lettuce production timeline

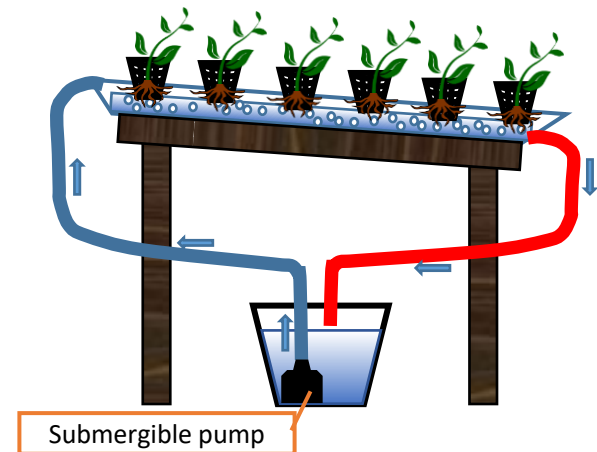


Systems adequate for leafy greens

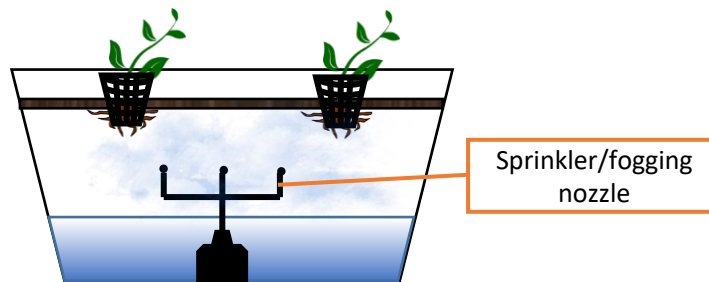
Floating raft/Deep water culture (DWC)



NFT



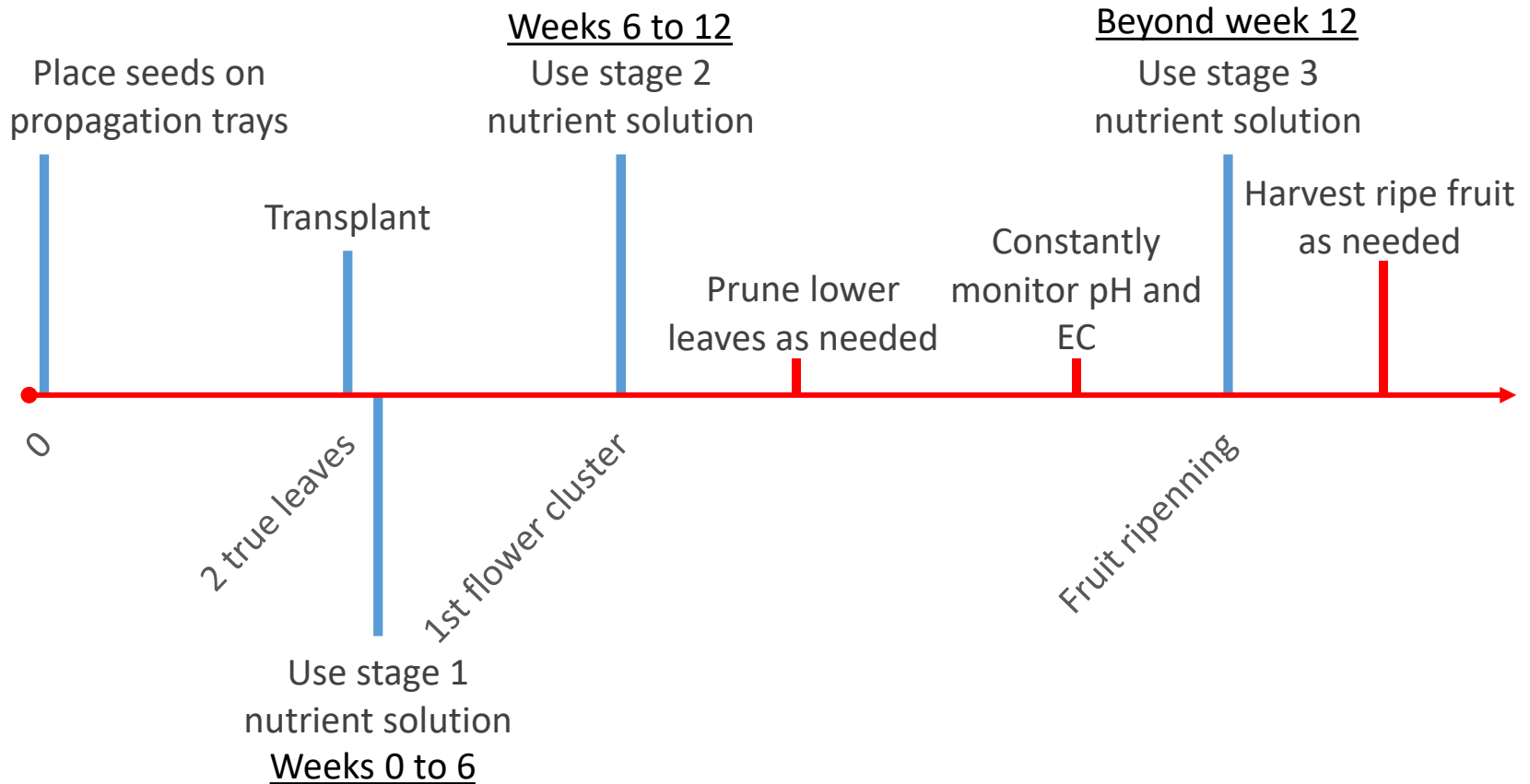
Aeroponic



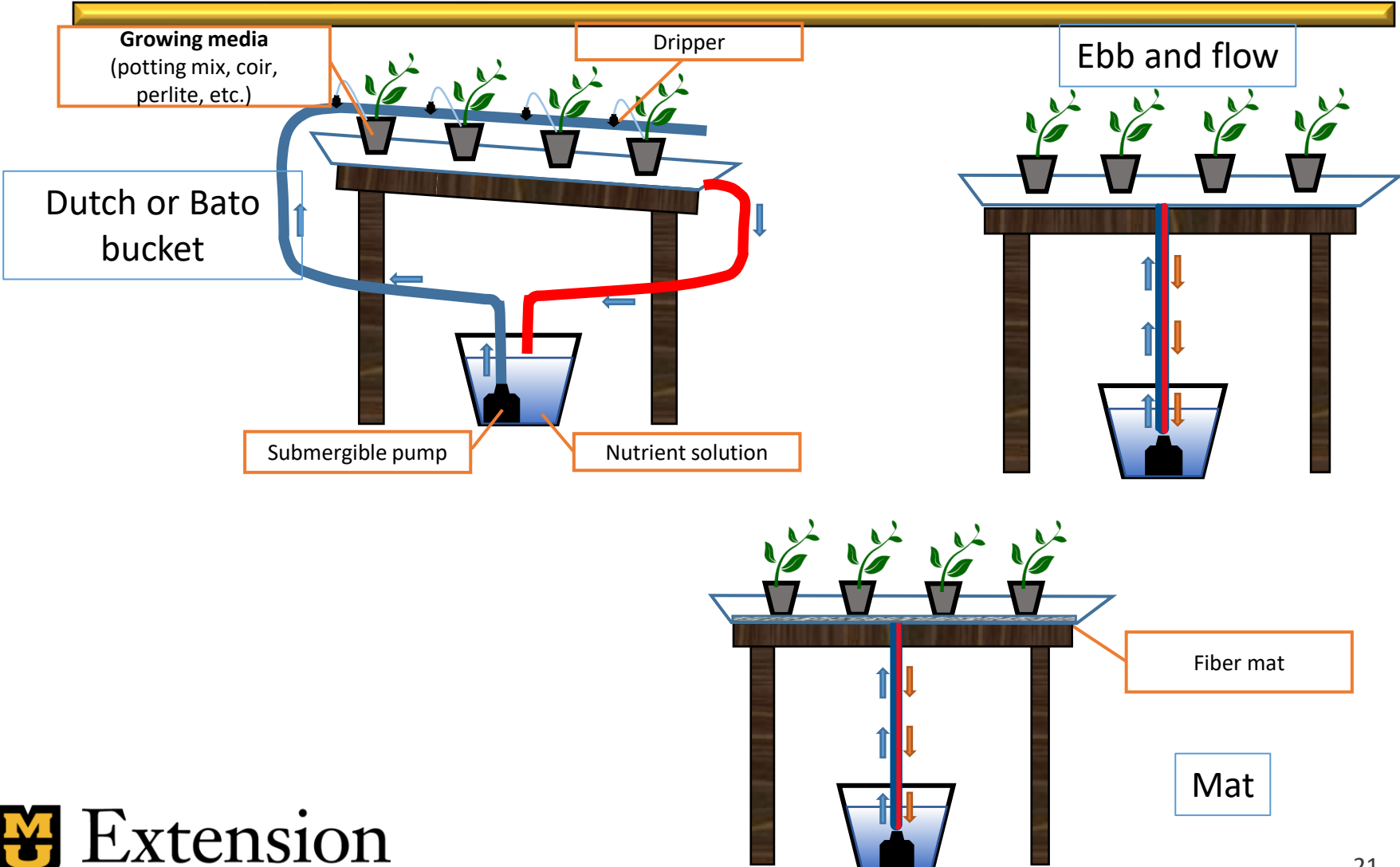
Taking care of lettuce plants

- Place sticky traps near vents, doors, and at the canopy level of the crops to scout for insects
- Scout for insect damage, diseases, yellowing or abnormal growth
- Measure pH, EC, and DO (DWC systems) every two days. Adjust pH when necessary
- Use summer heat resistant varieties in the summer
- Top off with fresh nutrient solution when needed
- Replace nutrient solution after 3 crop cycles

Hydroponic tomato production timeline



Systems adequate for vine crops



Taking care of tomato plants

- Place sticky traps near vents, doors, and at the canopy level of the crops to monitor for insects
- Measure pH and EC every two days and adjust pH when necessary
- Walk through and observe the plants for insect damage, diseases, yellowing or abnormal growth
- Prune lower leaves and adjust plant on the trellis
- Tomatoes need pollination!
- Replace nutrient solutions when needed

Pollinating tomatoes

- There are no pollinators inside a greenhouse or a vertical farms
- Pollination is needed to increase yield and fruit size
- You can order a box of bumblebees that will last for 12 weeks, and it is good for 1,400 to 5,700 sq ft (too many can damage flowers)
- Tap the trellis wire twice a day at least 3 days a week
- Use electric air blowers every day for 5 seconds



Trellis system



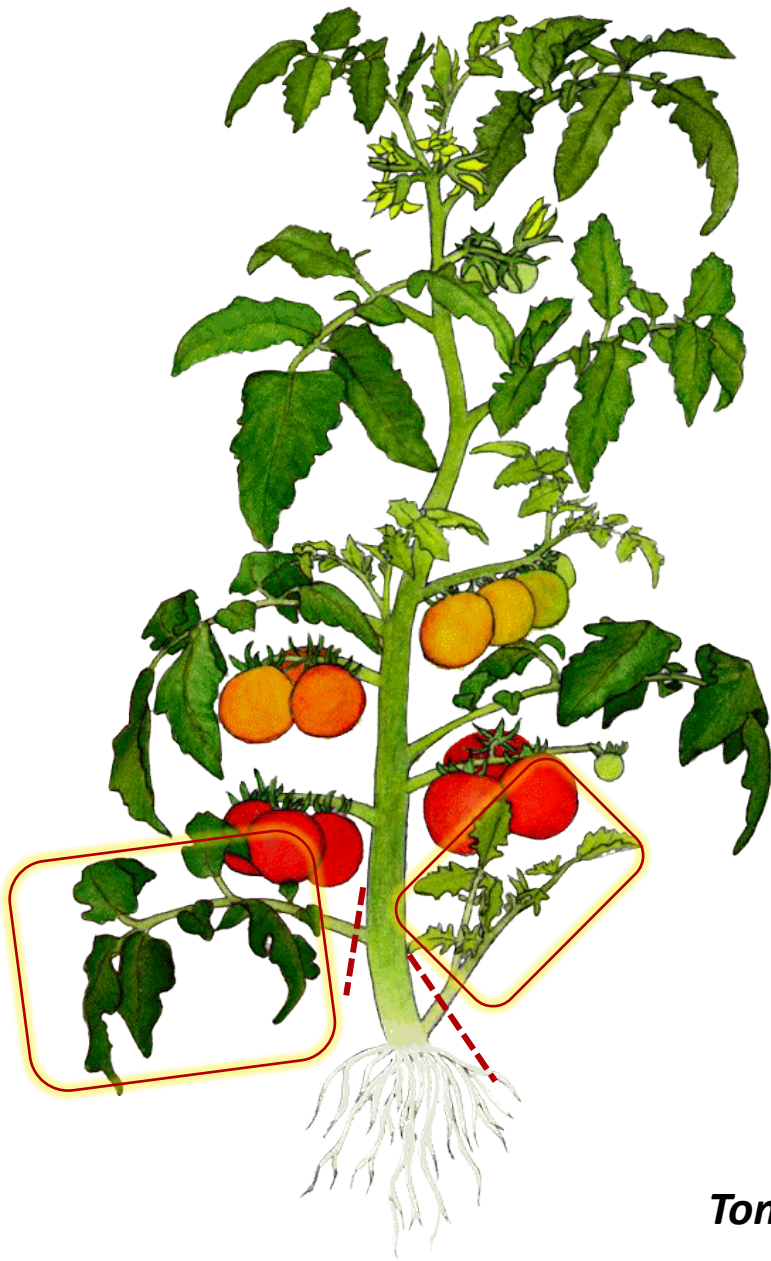
Pruning



Improved air circulation = Less disease pressure

Makes it easy to train the tomato plants

This Photo by Unknown Author is licensed under [CC BY](https://creativecommons.org/licenses/by/4.0/)



Remove any suckers

Remove lower leaves
no longer needed for
production: all leaves
under the first fruit
cluster

Tomato plant illustration by K. Tomlinson

Available at



Extension
University of Missouri

<https://cals.arizona.edu/hydroponictomatoes/pruning.htm>

Topics

1. Plant production timelines: lettuce and tomatoes
2. Seedling production
3. Making nutrient solutions
4. Hydroponic crop production Leafy greens and vine crops
 - Taking care of lettuce crops
 - Taking care of tomato crops
5. Monitoring nutrient solutions and pests

Measuring pH and EC



Measuring pH and EC



- Cheap meters can take wrong readings that can result in costly mistakes.
- A meter is as precise as the last time it was calibrated.



Extension

University of Missouri

Needed meters

		NFT & Dutch Bucket	DWC
Combo meters	pH	✓	✓
	Electric conductivity (EC)	✓	✓
	Temperature	✓	✓
	Dissolved oxygen (DO)	⊘	✓

Monitoring for pests

- Use sticky traps to scout for insects
 - At plant height
 - Yellow: fungus gnats, aphids, thrips, whiteflies, and leaf miners
 - Blue: whiteflies
 - One trap per 1,000 square feet
 - Additional traps as needed near vents and doors
 - Always inspect the plants
- Identify the pests and the damage they cause (some transmit plant diseases)

Sticky traps

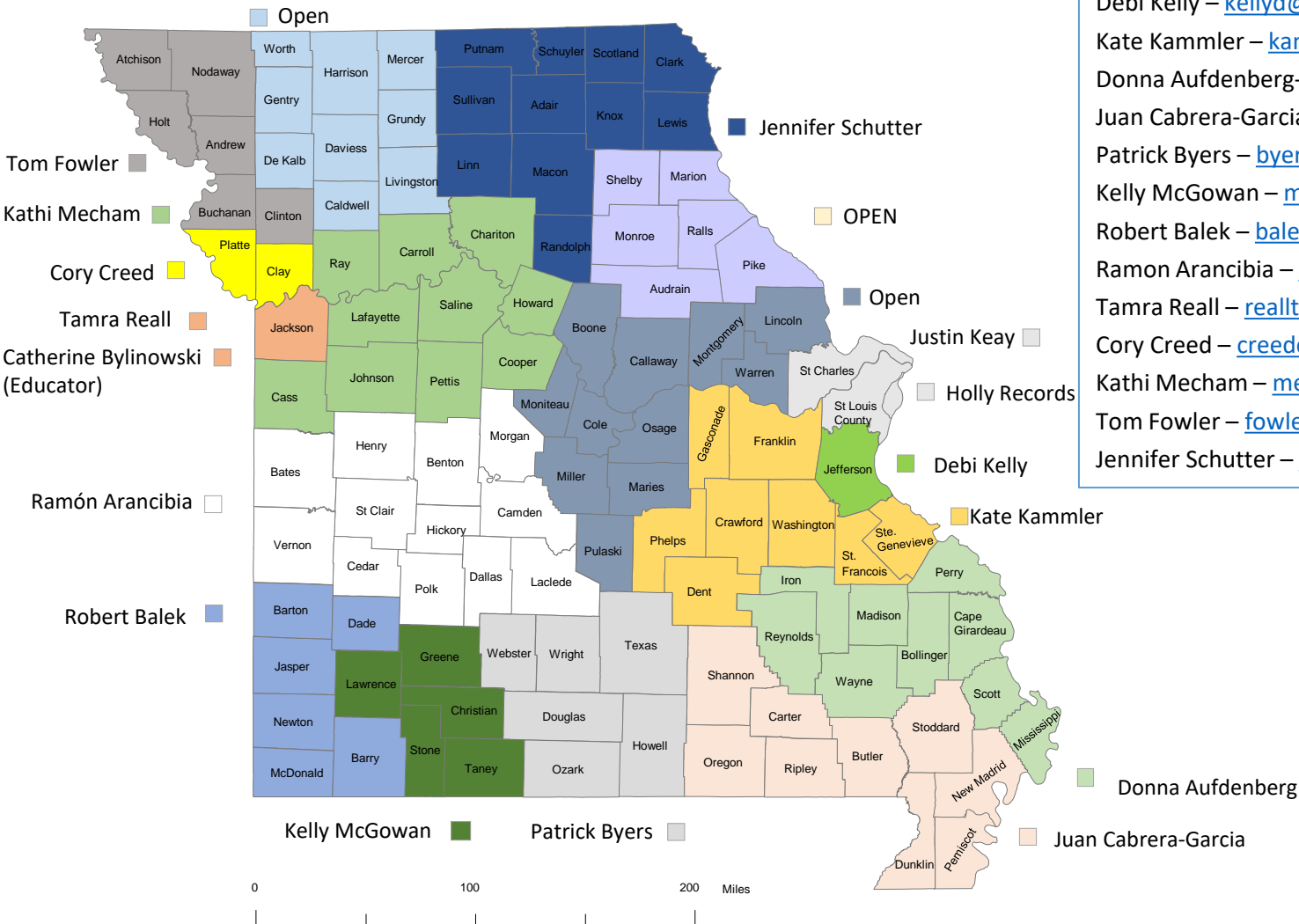


Insect pests

- Indoor/greenhouse: thrips, aphids, whiteflies, fungus gnat, and shoreflies
- Cultural control: resistant varieties, prevention measures, insecticidal soaps, horticultural oils, neem oil.
- Chemical control: Read the label! The label is the law!
- Biological control: predatory insects and beneficial fungi



Horticulture Specialists



- Justin Keay – Justin.keay@missouri.edu
- Debi Kelly – kellyd@missouri.edu
- Kate Kammler – kammlerk@missouri.edu
- Donna Aufdenberg- aufdenbergd@missouri.edu
- Juan Cabrera-Garcia – jcabrera-garcia@missouri.edu
- Patrick Byers – byerspl@Missouri.edu
- Kelly McGowan – mcgowank@Missouri.edu
- Robert Balek – balekr@Missouri.edu
- Ramon Arancibia – ramon.arancibia@Missouri.edu
- Tamra Reall – reallt@Missouri.edu
- Cory Creed – creedca@Missouri.edu
- Kathi Mecham – mechamk@Missouri.edu
- Tom Fowler – fowlert@Missouri.edu
- Jennifer Schutter – schutterjl@Missouri.edu