2026 GREENHOUSE HYDROPONIC TOMATO WORKSHOP

AT THE UA-CEAC WITH DR. TRISTON HOOKS

3-DAYS, JAN 9-11, FRI-SUN

- PROFESSIONAL KNOWLEDGE AND HANDS-ON SKILLS
- LEARN TO GROW THE BEST TASTING TOMATOES!

Controlled Environment Agriculture Center

Table of Contents

ARIZONA

Introduction

Dr. Triston Hooks
Assistant Professor of Practice, University of Arizona

About Dr. Triston Hooks

Dr. Triston Hooks graduated with a Ph.D. in Plant and Environmental Sciences from New Mexico State University in 2020, where he researched rangeland ecology and plant salinity tolerance. Additionally, he has worked as a Research Associate at Texas A&M AgriLife Research Center in Dallas, where his research focused on Urban Agriculture and Controlled Environment Agriculture (CEA) technology, including hydroponic systems and LED lighting. Dr. Hooks has conducted research on organic hydroponic production of lettuce and the application of ultra-violet (UV) light to enhance plant quality in greenhouse production systems. Dr. Hooks now serves as an Assistant Professor of Practice in the Department of Biosystems Engineering at the University of Arizona. He teaches Introduction to Hydroponics, Advanced Hydroponic Crop Production, Integrated Pest Management, and is an instructor for many of our offerings, including our CEAC Intensive Workshops.

About the Teaching Greenhouse (TGH)

The Teaching Greenhouse (TGH) is a sawtooth style, 5,400 sqft. greenhouse equipped with a Ridder environmental control system, with pad and fan-based mechanical cooling, and with natural gas-based unit heater as well as a Ridder fertigation system. The TGH has a capacity of 800-1200 vine crops, including but not limited to tomatoes, cucumbers, peppers, melons, pumpkins, etc. The TGH is used for the applied learning components of Dr. Hooks' courses. The introductory course is available for any student regardless of major, so that any UA student can learn to grow nutritious food or cultivate a passion for CEA.

ARIZONA

Hydroponic Tomato Intensive Workshop

Friday, January 9th

Morning Session (Online and In-Person)

9:00 am - 10:00 am	Introductions, CEAC History, Workshop Overview
10:00 am - 11:00 am	Principles of CEA and Hydroponics
11:00 am - 12:00 pm	Hydroponic Substrate and Tomato Propagation

Afternoon Session (In-Person Only)

12:00 pm - 1:00 pm	Lunch Provided
1:00 pm - 2:30 pm	CEAC Facilities Tour
2:30 pm - 3:00 pm	Break
3:00 pm - 5:00 pm	Hands-on Greenhouse Hydroponic Tomato Propagation, Boosting, and Transplanting

Hydroponic Tomato Intensive Workshop

Saturday, January 10th

Morning Session (Online and In-Person)

9:00 am - 10:00 am	**Hydroponic Nutrient Solutions**
10:00 am - 11:00 am	**Tomato Nutrient Deficiencies**
11:00 am - 12:00 pm	**Tomato Morphology and Plant Steering**

Afternoon Session (In-Person Only)

12:00 pm - 1:00 pm	**Lunch Provided**
1:00 pm - 2:30 pm	**Hands-on with Hydroponic Nutrient Solutions, Stock Replenishment, EC/pH, and Lysimeters**
2:30 pm - 3:00 pm	**Break**
3:00 pm - 5:00pm	**Hands-on Greenhouse Hydroponic Tomato Steering (pruning, C-clips, and lowering and leaning)**

Hydroponic Tomato Intensive Workshop

Sunday, January 11th

Morning Session (Online and In-Person)

9:00 am - 10:00 am	Integrated Pest Management (IPM) for Tomato
10:00 am - 11:00 am	Tomato Pollination, Fruit, and Harvesting and Grading
11:00 am - 12:00 pm	Q&A with CEAC Faculty

Afternoon Session (In-Person Only)

12:00 pm - 1:00 pm	Lunch Provided
1:00 pm - 2:30 pm	Hands-on with pest ID, beneficial insects, bumblebee hive demo, and tomato pollination
2:30 pm - 3:00 pm	Break
3:00 pm - 5:00 pm	Hands-on Tomato Harvesting, Grading, and Tasting with BRIX (sugar) measurements
5:00 pm - 5:30 pm	Group Photo and Farewells

1
2
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6
7
Parking
1. Classroom
2. Teaching Greenhouse
3. AdvanCEA Greenhouse
4. Indoor Vertical Farm
5. Headhouse
6. Aquaponics Greenhouse
7. Mushroom Lab Exhibit
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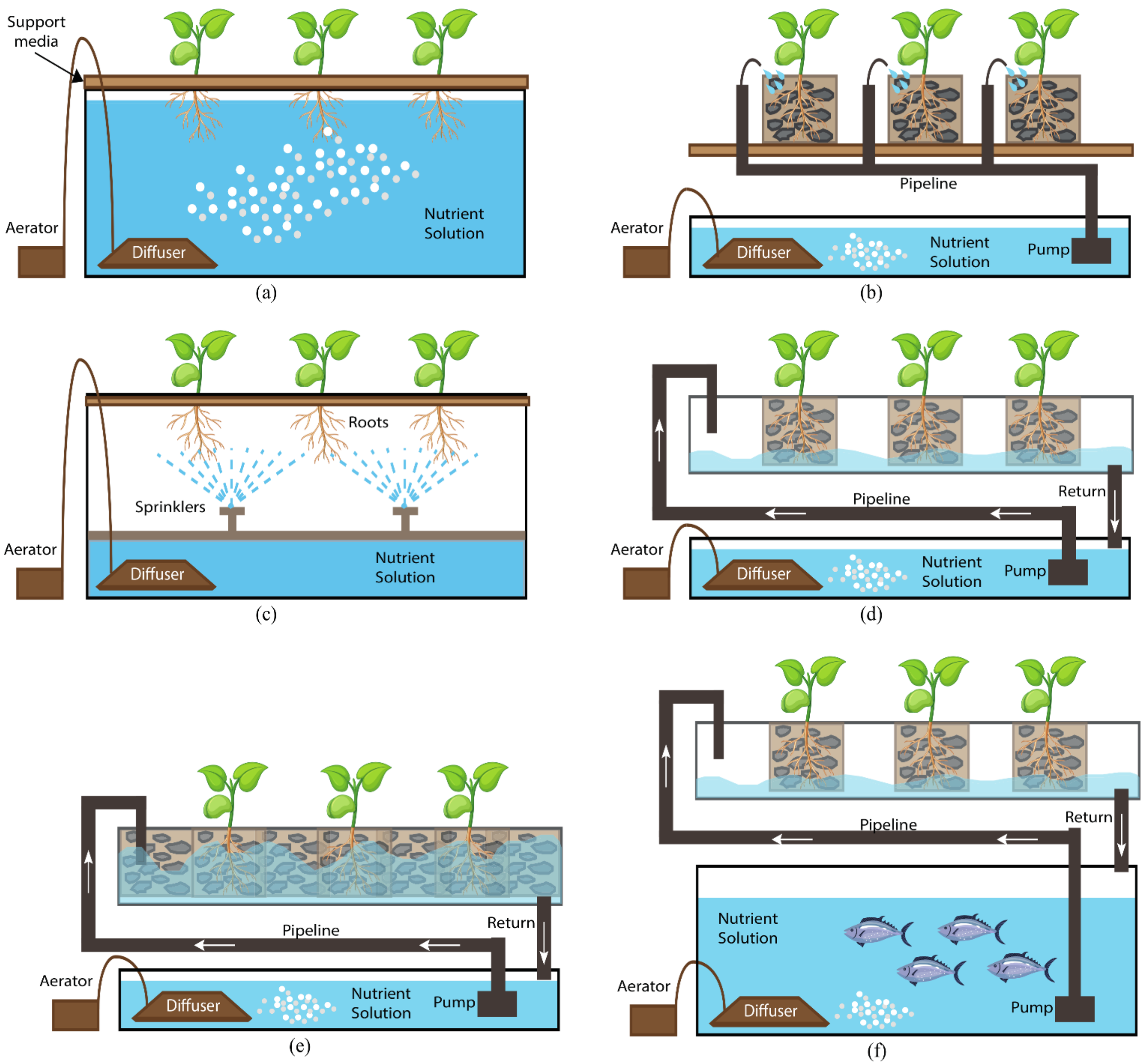
Hydroponic Systems



(a) Deep Water Culture

(b) Drip System

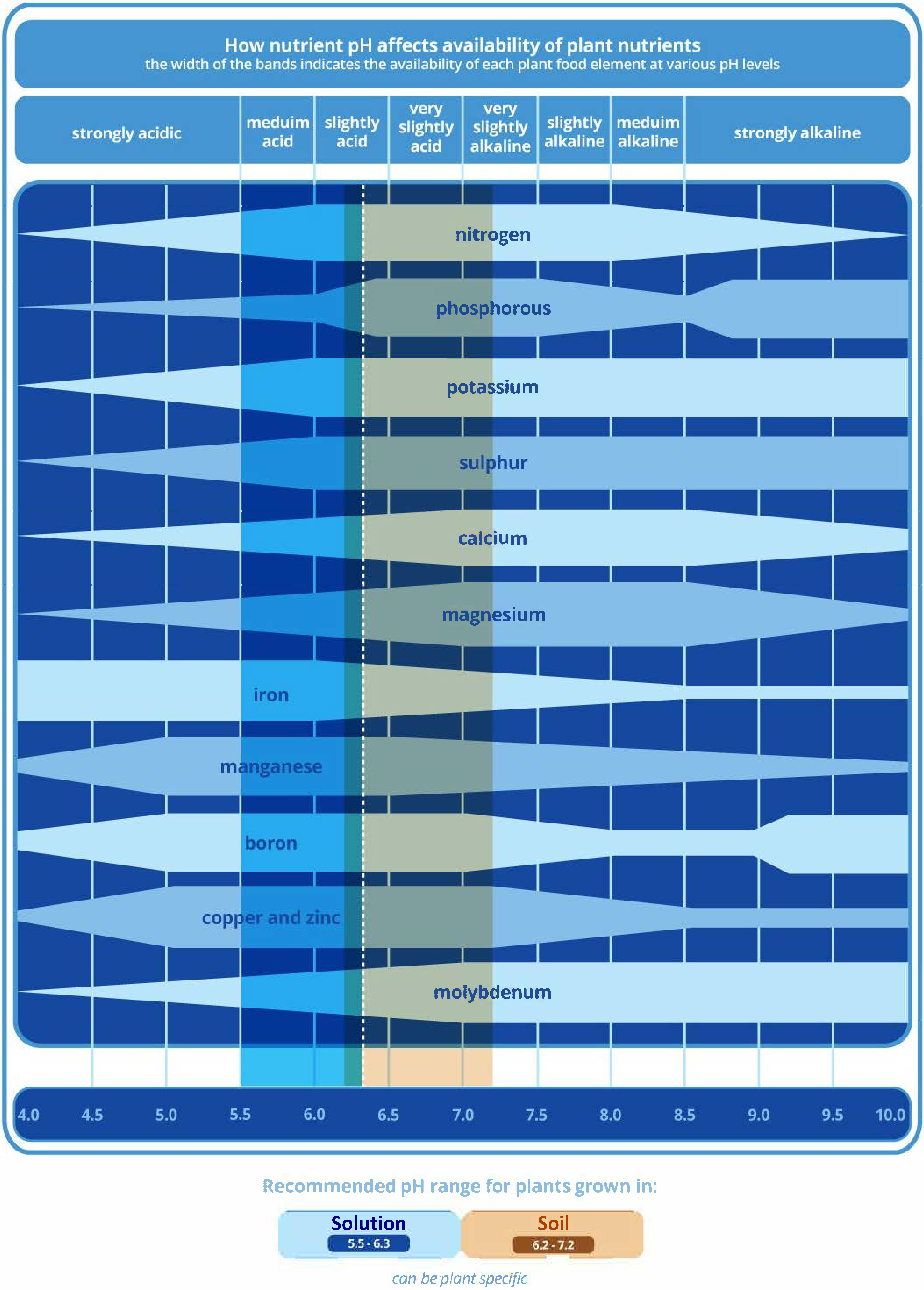
(c) Aeroponics

(d) Nutrient Film Technique (NFT)

(e) Ebb and flow

(f) Aquaponics

Velazquez-Gonzalez, Roberto & Garcia-Garcia, Adrian & Ventura-Zapata, Elsa & Barceinas-Sanchez, Jose & Sosa-Savedra, Julio. (2022). A Review on Hydroponics and the Technologies Associated for Medium- and Small-Scale Operations. Agriculture. 12. 646. 10.3390/agriculture12050646.



How nutrient pH affects availability of plant nutrients
the width of the bands indicates the availability of each plant food element at various pH levels
strongly acidic
meduim acid
slightly acid
very slightly acid
very slightly alkaline
slightly alkaline
meduim alkaline
strongly alkaline
nitrogen
phosphorous
potassium
sulphur
calcium
magnesium
iron
manganese
boron
copper and zinc
molybdenum
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
Recommended pH range for plants grown in:
Solution
5.5 - 6.3
Soil
6.2 - 7.2
can be plant specific

PERIODIC TABLE OF ELEMENTS

PubChem

1
H
Hydrogen
1.0080

Atomic Number
Symbol
Name
Atomic Mass, u

1 **H** Hydrogen 1.0080																	2 **He** Helium 4.00260
3 **Li** Lithium 7.0	4 **Be** Beryllium 9.012183											5 **B** Boron 10.81	6 **C** Carbon 12.011	7 **N** Nitrogen 14.007	8 **O** Oxygen 15.999	9 **F** Fluorine 18.99840316	10 **Ne** Neon 20.180
11 **Na** Sodium 22.9897693	12 **Mg** Magnesium 24.305											13 **Al** Aluminum 26.981538	14 **Si** Silicon 28.085	15 **P** Phosphorus 30.97376200	16 **S** Sulfur 32.07	17 **Cl** Chlorine 35.45	18 **Ar** Argon 39.9
19 **K** Potassium 39.098	20 **Ca** Calcium 40.08	21 **Sc** Scandium 44.95591	22 **Ti** Titanium 47.87	23 **V** Vanadium 50.941	24 **Cr** Chromium 51.996	25 **Mn** Manganese 54.93804	26 **Fe** Iron 55.84	27 **Co** Cobalt 58.93319	28 **Ni** Nickel 58.693	29 **Cu** Copper 63.55	30 **Zn** Zinc 65.4	31 **Ga** Gallium 69.72	32 **Ge** Germanium 72.63	33 **As** Arsenic 74.92159	34 **Se** Selenium 78.97	35 **Br** Bromine 79.90	36 **Kr** Krypton 83.80
37 **Rb** Rubidium 85.468	38 **Sr** Strontium 87.6	39 **Y** Yttrium 88.9058	40 **Zr** Zirconium 91.22	41 **Nb** Niobium 92.9064	42 **Mo** Molybdenum 96.0	43 **Tc** Technetium 97.90721	44 **Ru** Ruthenium 101.1	45 **Rh** Rhodium 102.9055	46 **Pd** Palladium 106.4	47 **Ag** Silver 107.868	48 **Cd** Cadmium 112.41	49 **In** Indium 114.82	50 **Sn** Tin 118.71	51 **Sb** Antimony 121.76	52 **Te** Tellurium 127.6	53 **I** Iodine 126.9045	54 **Xe** Xenon 131.29
55 **Cs** Cesium 132.9054520	56 **Ba** Barium 137.33	*	72 **Hf** Hafnium 178.5	73 **Ta** Tantalum 180.9479	74 **W** Tungsten 183.8	75 **Re** Rhenium 186.21	76 **Os** Osmium 190.2	77 **Ir** Iridium 192.22	78 **Pt** Platinum 195.08	79 **Au** Gold 196.96657	80 **Hg** Mercury 200.59	81 **Tl** Thallium 204.383	82 **Pb** Lead 207	83 **Bi** Bismuth 208.9804	84 **Po** Polonium 208.98243	85 **At** Astatine 209.98715	86 **Rn** Radon 222.01758
87 **Fr** Francium 223.01973	88 **Ra** Radium 226.02541	**	104 **Rf** Rutherfordium 267.122	105 **Db** Dubnium 268.126	106 **Sg** Seaborgium 271.134	107 **Bh** Bohrium 274.144	108 **Hs** Hassium 277.152	109 **Mt** Meitnerium 278.156	110 **Ds** Darmstadtium 281.165	111 **Rg** Roentgenium 282.169	112 **Cn** Copernicium 285.177	113 **Nh** Nihonium 286.183	114 **Fl** Flerovium 289.191	115 **Mc** Moscovium 290.196	116 **Lv** Livermorium 293.205	117 **Ts** Tennessine 294.211	118 **Og** Oganesson 294.214
		*	57 **La** Lanthanum 138.9055	58 **Ce** Cerium 140.12	59 **Pr** Praseodymium 140.9077	60 **Nd** Neodymium 144.24	61 **Pm** Promethium 144.91276	62 **Sm** Samarium 150.4	63 **Eu** Europium 151.96	64 **Gd** Gadolinium 157.2	65 **Tb** Terbium 158.92535	66 **Dy** Dysprosium 162.50	67 **Ho** Holmium 164.93033	68 **Er** Erbium 167.26	69 **Tm** Thulium 168.93422	70 **Yb** Ytterbium 173.04	71 **Lu** Lutetium 174.967
		**	89 **Ac** Actinium 227.02775	90 **Th** Thorium 232.038	91 **Pa** Protactinium 231.0359	92 **U** Uranium 238.0289	93 **Np** Neptunium 237.04817	94 **Pu** Plutonium 244.06420	95 **Am** Americium 243.06138	96 **Cm** Curium 247.07035	97 **Bk** Berkelium 247.07031	98 **Cf** Californium 251.07959	99 **Es** Einsteinium 252.0830	100 **Fm** Fermium 257.09511	101 **Md** Mendelevium 258.09843	102 **No** Nobelium 259.10100	103 **Lr** Lawrencium 262.110

UA-CEAC Greenhouse Hydroponic Tomato Recipes

Element	1/2x Propagation (Week 0 - 4) ppm (mg/L)	1. Vegetative (Week 4 - 8) ppm (mg/L)	2. Generative (Week 8 - 12) ppm (mg/L)	3. Balanced (Week 12+) ppm (mg/L)
N	80	160	170	200
P	20	40	47	50
K	85	170	240	260
Ca	90	180	200	230
Mg	25	50	60	70
S	35	70	100	120
Cl	15	30	50	60
Fe	1.0	2.0	2.5	3.0
Mn	0.35	0.70	0.70	0.70
B	0.20	0.40	0.40	0.40
Zn	0.17	0.33	0.33	0.33
Cu	0.03	0.06	0.06	0.06
Mo	0.03	0.06	0.06	0.06
TDS:	**352**	**704**	**871**	**995**
EC:	**0.5**	**1.1**	**1.4**	**1.6**
EC+tap:	**0.9**	**1.5**	**1.8**	**2.0**
pH:	**6.0**	**6.0**	**5.8**	**6.0**

Updated 2025, Hooks

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NUTRIENT SOLUTION CALCULATIONS

Hooks 2025

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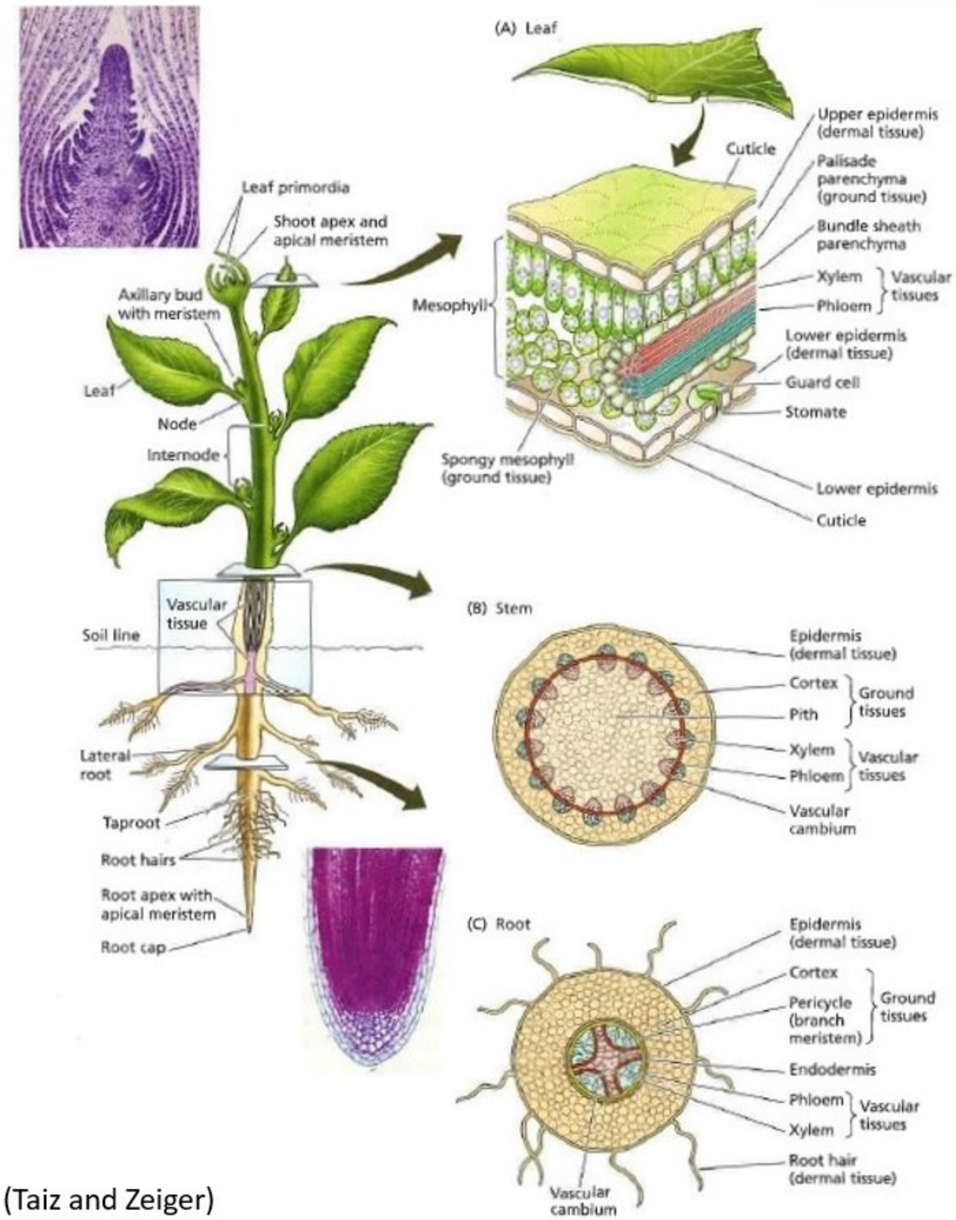
Tomato Recipe 1 - Vegetative

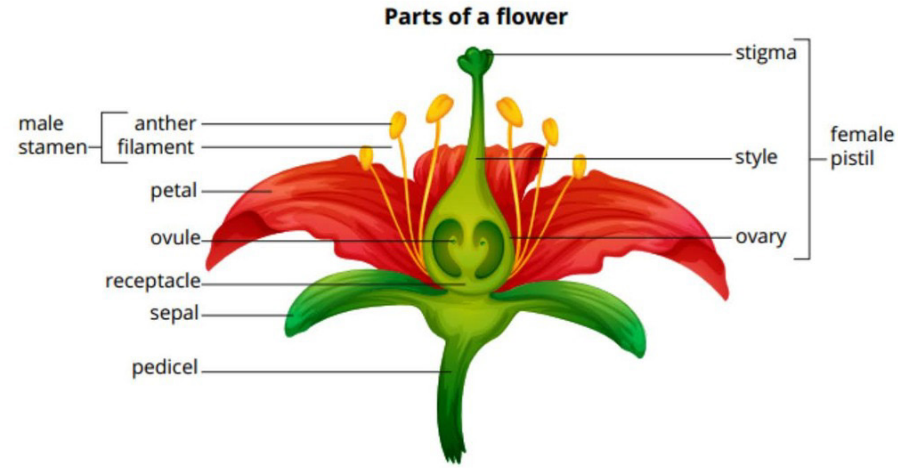
Step 1	**Stock Volume (L):**	**303**
Step 2	**Stock Concentrate (X):**	**200**

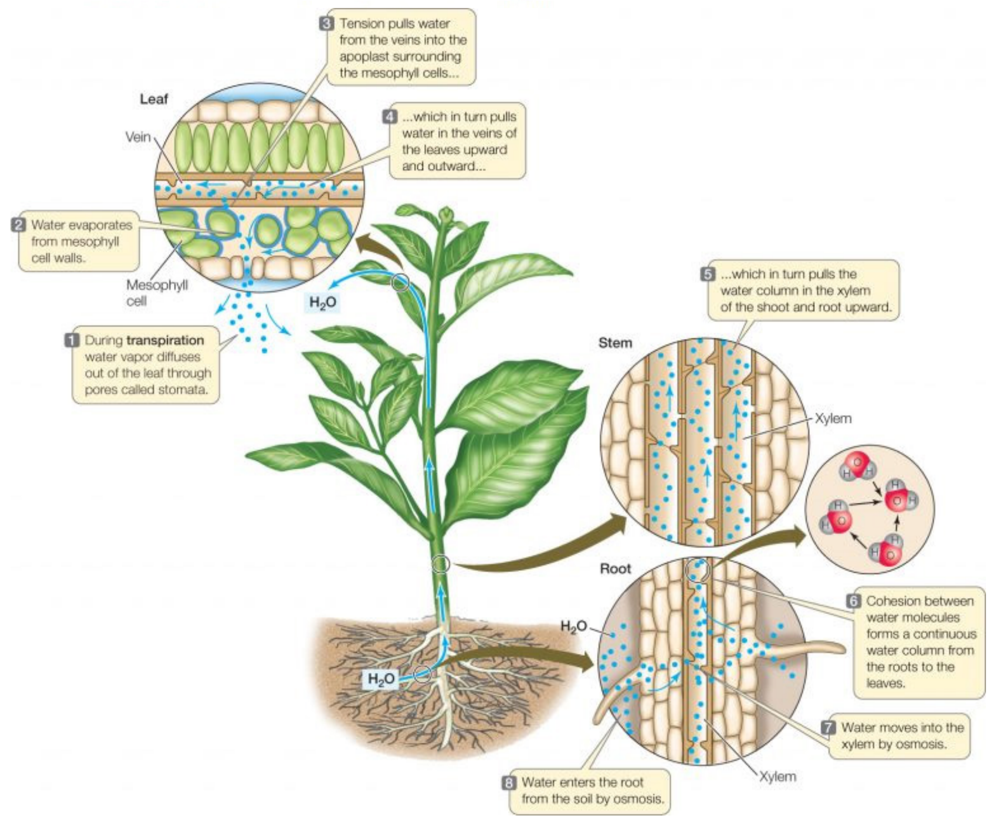
Step 3	**Set your nutrient ppms:**	*(ppm x L x X /1000)*					*(AM/FW)*	*(g x % element)*
Element	Target ppm	g (element)	Primary fertilizer salt	Chemical formula	FW	AM	% element	g (fertilizer salt)
N	160	9696	Potassium nitrate	KNO_3	101.11	14.01	0.14	69991
P	40	2424	Potassium phosphate	KH_2PO_4	136.09	30.97	0.23	10650
K	170	10302	Potassium sulfate	K_2SO_4	174.26	39.10	0.45	22958
Ca	180		Calcium amm. nitrate	$CaH_4N_2O_3$	120.12	40.08	0.33	
Mg	50		Magnesium sulfate	$MgSO_4\,7H_2O$	246.48	24.31	0.10	
S	70		Magnesium sulfate	$MgSO_4\,7H_2O$	246.48	32.07	0.13	
Cl	30		Calcium chloride	$CaCl_2\,2H_2O$	147.01	35.45	0.48	
Fe	2.0		Iron chelate	EDDHA	NA	55.84	0.06	
Mn	0.70		Mangenese sulfate	$MnSO_4\,4H_2O$	223.06	54.94	0.25	
B	0.40		Boric acid	H_3BO_3	61.83	10.81	0.17	
Zn	0.33		Zinc sulfate	$ZnSO_4\,7H_2O$	287.58	65.40	0.23	
Cu	0.06		Copper sulfate	$CuSO_4\,5H_2O$	249.68	63.55	0.25	
Mo	0.06		Sodium Molybdate	$MoNa_2O_4$	205.93	95.95	0.47	

Plant Morphology & Transpiration



(Taiz and Zeiger)





CROP REGISTRATION AND
STEERING YOUR TOMATOES TOWARD PROFIT

Merle H. Jensen
University of Arizona
College of Agriculture
Tucson, Arizona 85721

For a grower to maximize profits it is important to keep the growth and reproduction of the tomato plant in balance. If the plant becomes either too reproductive (generative) or vegetative, fruit size and yield will decrease. It takes a great deal of horticultural skill to steer the plant, so neither mode of growth becomes dominant.

As an aid to unskilled growers, table 1 lists the plant characteristics for reproductive and vegetative growth.

Table 1: Steering the tomato plant: reproductive versus vegetative growth

Characteristic	Reproductive (Generative) Growth	Vegetative Growth
Leaves	Flat and open, light green, soft	Curled, thick, dark green
Flowering	Close to the top of the plant Flowers open fast and uniform Rapid flowering within truss	Further from the top of the plant Flowers open poorly; sepals stick Poor uniform flowering within truss
Flower Color	Dark yellow	Pale, light yellow
Truss Stem	Thick, sturdy, short and curved	Thin, long and sticking upwards
Fruit	Large, many, good shape and fast development	Small, few, poor shape and slow development

While steering plant growth is important at any time of the year, it is especially important at the beginning of the crop, if the crop is planted to the greenhouse during the winter. How the crop is started during periods of lower light will set the tone for the entire life of the crop.

To control or steer plant growth, a grower can make adjustments to the greenhouse temperatures as well as the carbon dioxide (CO_2), the humidity, the electrical conductivity (EC) of the nutrient solution, the irrigation frequency and volume and the pruning of the tomato plant. How the grower manages the above parameters will cause a reproductive action or vegetative action. For example, a grower can make the plant more reproductive, if the difference of the day/night temperature is greater. In nature, anytime a plant is exposed to stress- such as drought, high salts, low water and cold, the plant will go into a reproductive mode of growth. Placing the plant under opposite conditions, or more tropical in nature, the plant will show a more lush growth or vegetative response.

Table 2**: Steering plant growth for maximum yield.**

Action	**Reproductive Actions**	**Vegetative Actions**
Difference in Day/Night Temperature	Greater	Smaller
24-hour Temperature	Low (<20°C)	High (>22°C)
Cooling down; Day> Night	Fast (i.e. using a Pre-night temperature strategy	Slow
VPD (Humidity)	Larger (Low R.H.)	Smaller (High R.H.)
Ventilating (Mind the outside temperature)	More	Less
CO2	500 - 1000 ppm	300- 400 ppm
EC in the slab	Higher (NOT more K) Tomato; 4.5+ mS Cucumber; 2.8 - 3.2 mS	Lower Tomato; 4 - 4.5 mS Cucumber; 2 - 2.5 mS
EC in the drip	Higher	Lower
Water content in the slab	Lower; 10-15% Day/Night difference	Higher and Constant; 4-6% Day/Night difference
Irrigation frequency and irrigation volume	Less frequent; Large volume per irrigation	More frequent; Small volume per irrigation
Irrigation start time	Later in the morning	Earlier in the morning
Irrigation stop time	Earlier in the afternoon	Later in the afternoon (unless root problems)
Truss pruning (tomato)	Less (leave more fruit)	More (take off more fruit)
Truss supports (tomato)	More; sooner	Less, later

Taking these various actions will definitely work. Naturally, it is important to have full capability to maximize the results in steering plant growth.

Unfortunately, many greenhouses, especially in Mexico, are unheated, therefore the option to increase or decrease day/night temperatures can be limited. This greatly limits the capability to steer plant growth. It is extremely important for growers to have all available options if beefsteak tomatoes are grown.

Large, high quality beefsteak tomatoes cannot be grown in greenhouses that lack ample control of the environment. Smaller fruited cultivars are possible, but yields will not always be at their maximum.

VPD (kPa) Chart for CEA Plant Steering

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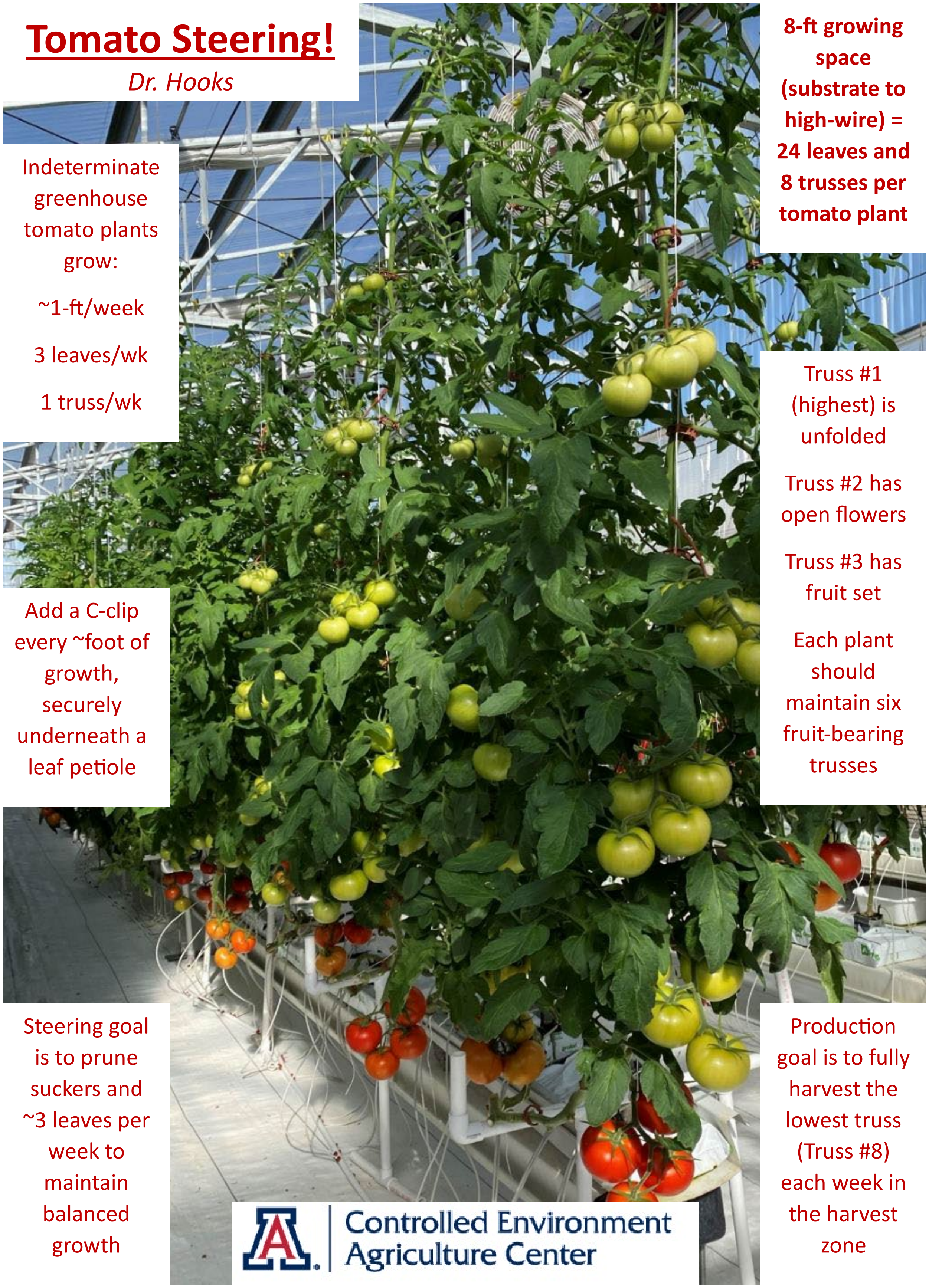
		RH (%)																
C	**F**	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
15	59	1.53	1.45	1.36	1.28	1.19	1.11	1.02	0.94	0.85	0.77	0.68	0.60	0.51	0.43	0.34	0.26	0.17
16	61	1.64	1.55	1.45	1.36	1.27	1.18	1.09	1.00	0.91	0.82	0.73	0.64	0.55	0.45	0.36	0.27	0.18
17	63	1.74	1.65	1.55	1.45	1.36	1.26	1.16	1.07	0.97	0.87	0.78	0.68	0.58	0.48	0.39	0.29	0.19
18	64	1.86	1.75	1.65	1.55	1.44	1.34	1.24	1.14	1.03	0.93	0.83	0.72	0.62	0.52	0.41	0.31	0.21
19	66	1.98	1.87	1.76	1.65	1.54	1.43	1.32	1.21	1.10	0.99	0.88	0.77	0.66	0.55	0.44	0.33	0.22
20	68	2.10	1.99	1.87	1.75	1.64	1.52	1.40	1.29	1.17	1.05	0.94	0.82	0.70	0.58	0.47	0.35	0.23
21	70	2.24	2.11	1.99	1.87	1.74	1.62	1.49	1.37	1.24	1.12	0.99	0.87	0.75	0.62	0.50	0.37	0.25
22	72	2.38	2.25	2.11	1.98	1.85	1.72	1.59	1.45	1.32	1.19	1.06	0.93	0.79	0.66	0.53	0.40	0.26
23	73	2.53	2.39	2.25	2.11	1.97	1.83	1.69	1.55	1.40	1.26	1.12	0.98	0.84	0.70	0.56	0.42	0.28
24	75	2.69	2.54	2.39	2.24	2.09	1.94	1.79	1.64	1.49	1.34	1.19	1.04	0.90	0.75	0.60	0.45	0.30
25	77	2.85	2.69	2.53	2.38	2.22	2.06	1.90	1.74	1.58	1.43	1.27	1.11	0.95	0.79	0.63	0.48	0.32
26	79	3.03	2.86	2.69	2.52	2.35	2.18	2.02	1.85	1.68	1.51	1.34	1.18	1.01	0.84	0.67	0.50	0.34
27	81	3.21	3.03	2.85	2.67	2.50	2.32	2.14	1.96	1.78	1.60	1.43	1.25	1.07	0.89	0.71	0.53	0.36
28	82	3.40	3.21	3.02	2.83	2.65	2.46	2.27	2.08	1.89	1.70	1.51	1.32	1.13	0.94	0.76	0.57	0.38
29	84	3.60	3.40	3.20	3.00	2.80	2.60	2.40	2.20	2.00	1.80	1.60	1.40	1.20	1.00	0.80	0.60	0.40
30	86	3.82	3.61	3.39	3.18	2.97	2.76	2.55	2.33	2.12	1.91	1.70	1.48	1.27	1.06	0.85	0.64	0.42
31	88	4.04	3.82	3.59	3.37	3.14	2.92	2.70	2.47	2.25	2.02	1.80	1.57	1.35	1.12	0.90	0.67	0.45
32	90	4.28	4.04	3.80	3.57	3.33	3.09	2.85	2.61	2.38	2.14	1.90	1.66	1.43	1.19	0.95	0.71	0.48
33	91	4.53	4.28	4.02	3.77	3.52	3.27	3.02	2.77	2.51	2.26	2.01	1.76	1.51	1.26	1.01	0.75	0.50
34	93	4.79	4.52	4.25	3.99	3.72	3.46	3.19	2.93	2.66	2.39	2.13	1.86	1.60	1.33	1.06	0.80	0.53
35	95	5.06	4.78	4.50	4.22	3.94	3.65	3.37	3.09	2.81	2.53	2.25	1.97	1.69	1.41	1.12	0.84	0.56

Tomato Steering!

Dr. Hooks



Indeterminate greenhouse tomato plants grow:

~1-ft/week

3 leaves/wk

1 truss/wk

8-ft growing space (substrate to high-wire) = 24 leaves and 8 trusses per tomato plant

Add a C-clip every ~foot of growth, securely underneath a leaf petiole

Truss #1 (highest) is unfolded

Truss #2 has open flowers

Truss #3 has fruit set

Each plant should maintain six fruit-bearing trusses

Steering goal is to prune suckers and ~3 leaves per week to maintain balanced growth

Production goal is to fully harvest the lowest truss (Truss #8) each week in the harvest zone

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For an 8-ft plant with 24 leaves, a ~2.5 ft Harvest Zone is made in the lower canopy by pruning 8 leaves. The plant should then have 16 leaves left (2 leaves per truss) for balanced source and sink tissue

The Harvest zone is the lower canopy (1/3 of growing space) where leaves are pruned and ripe fruit are visible and easy to harvest

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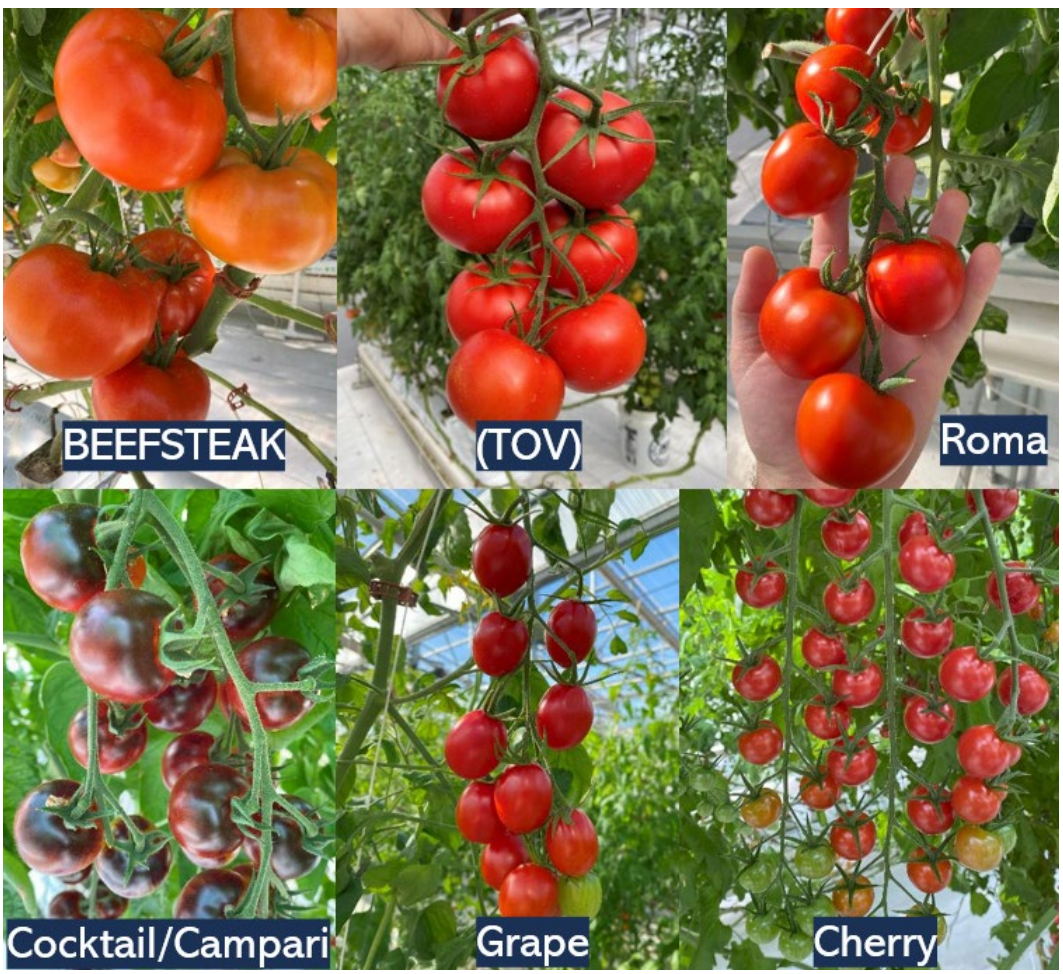
Expected Fruit per Truss

For greenhouse hydroponic indeterminate tomatoes

Tomato Type	Winter (Not ideal conditions)	Summer (Ideal conditions)
Beefsteak	2-3	3-4
TOV	3-5	5-7
Roma	4-6	6-8
Cocktail/Campari	6-10	10-14
Grape	8-12	12-16
Cherry	12-18	18-24



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TGH Tomato Grading Guide!

Beefsteak (Marbonne) Grade A >9 cm

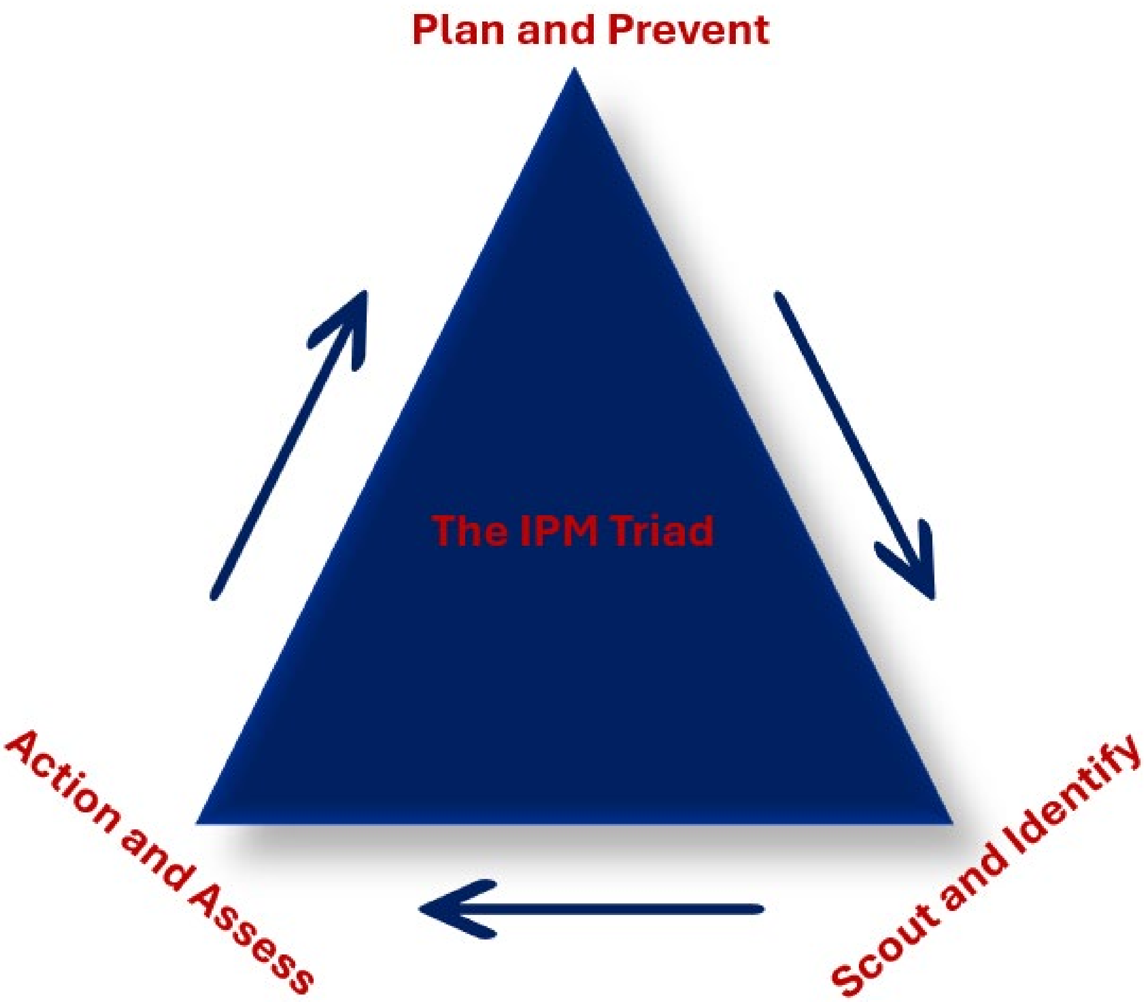
TOV (Estiva) Grade A >7 cm

Roma (San Marzano) Grade A >6 cm

Cherries (SS100) Grade A >2 cm

Campari (Indigos) Grade A >3 cm

Color	Stage 1 (solid green)	Stage 2 (breakers)	Stage 3 (pink)	Stage 4 (orange)	Stage 5 (red)	Stage 6 (dark red)	Over-ripe
Grade A (the best! 🏆)	-	-	-	-	Good size, good shape, minor defects		-
Grade B (OK! 👍)	Good size, good shape, minor defects	Too small or odd shape, minor or medium defects					
Grade C (Cull 💀)	Way too small or major defects such as open wounds, mold, BER, viruses, etc. (food safety related, please don't eat!)						

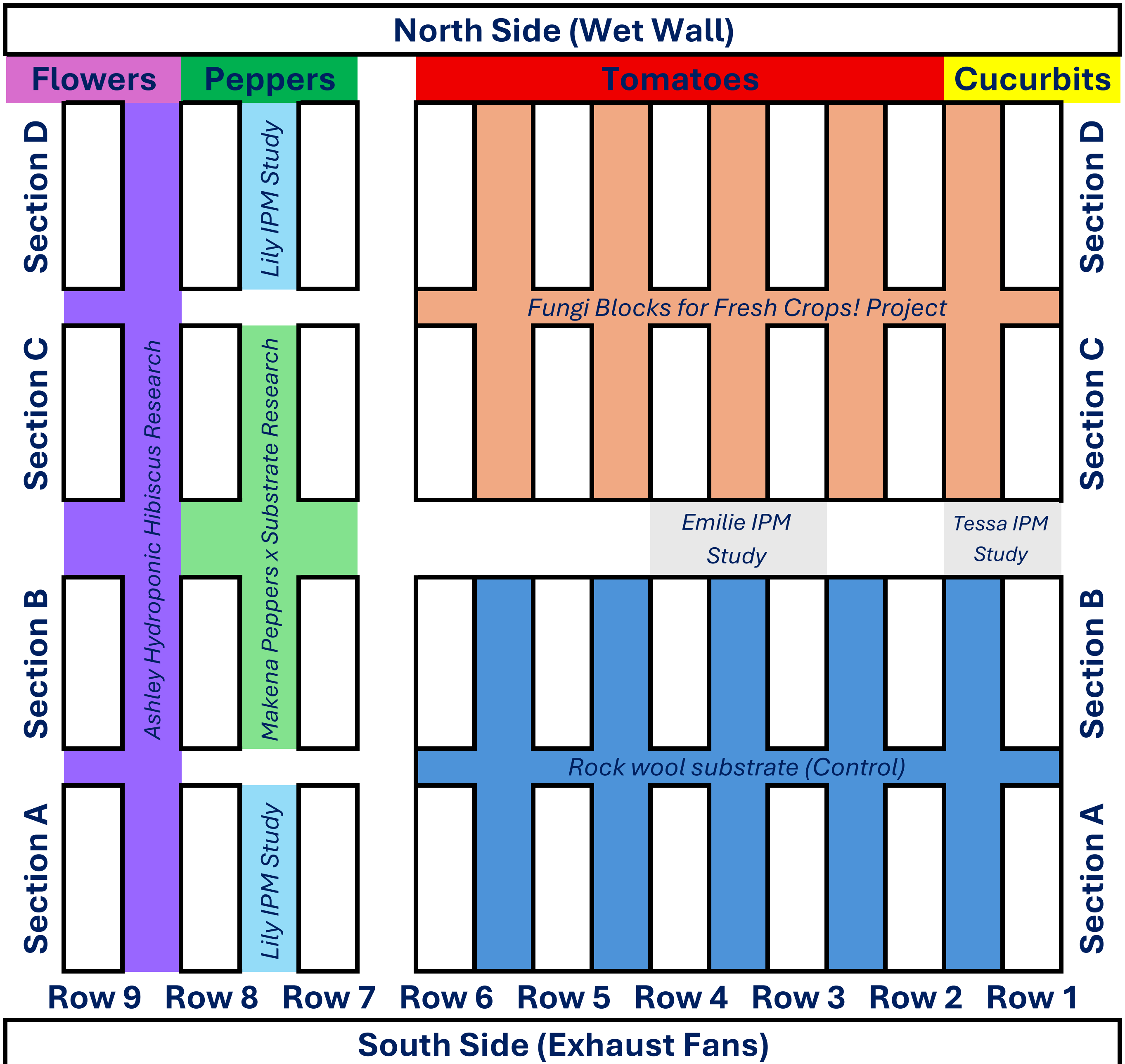


IPM Actions and hierarchal scale:

1. *Cultural (preventative)*
2. *Mechanical (physical)*
3. *Biological (beneficials)*
4. *Chemical (pesticides)*

Controlled Environment Agriculture Center

IPM Scout Map (TGH Fall 2025)



***Legend* (*Blue = Beneficial* , *Red = Pest* , *Yellow = Pathogen*)**

AN	*Ants*	**LH**	*Leafhopper*	**SB**	*Shield bug*	***Severity: (1-5)***
A	*Aphids*	**LM**	*Leaf miner*	**SM**	*Spider mites*	*Based on population and damage*
AB	Assassin bug	**L**	Looper	**TB**	*Tomato bug*	
CB	*Cucumber bug*	**M**	Mantid	**TH**	*Thrips*	
DF	*Drain fly*	**O**	*Other*	**TP**	*Tomato psyllid*	
FG	*Fungus gnat*	**PW**	Parasitic Wasp	**V**	Virus	**1 = Low**
LB	Ladybug	**PM**	Powdery Mildew	**WF**	*Whitefly*	**3 = Moderate**
LW	Lacewing	**RM**	*Russet mite*			**5 = High**

Notes

ARIZONA

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