



# Water Quality, Growing Media, and Fertilizer – Navigating the Greenhouse Bermuda Triangle

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# The Dynamic Relationship between Growing media, Water Quality and Fertility Sources

- Irrigation Water Quality – Soluble Salts, pH, and alkalinity.
- Growing Media – Physical and chemical properties
- Fertility sources – Nitrogen sources and impact on growing media pH.

# Water Quality - Soluble Salts

- Measured by Electrical Conductivity (EC)
- Seedlings less than 0.75 dS/m
- General crops less than 1.50 dS/m
- Relationship between EC and TDS  
$$\text{EC (dS/m)} \times 640 = \text{TDS (mg/L)}$$





# Water pH is known to impact:

- Availability of nutrients in the growing media
- Solubility of fertilizers in solutions
- Stability and efficiency of pesticides and growth regulators

# Alkalinity

The primary impact of water on growing media pH stems from irrigation water alkalinity level.

Alkalinity is a measure of the facility of water to raise pH.

Reported as milliequivalents/liter (me/l) or ppm of equivalent calcium carbonate.

1 me/l = 50 ppm

# Alkalinity

- **Water alkalinity causes substrate pH to rise gradually over time.**

- Length of crop period
- Plant-to-substrate ratio
- Upper substrate pH level tolerated by the crop



## Water quality guidelines and PGC water test results

The following lists the desirable qualities of irrigation water, as well as the results of a recent Plant Growth Center (PGC) irrigation water test. (mMhos/cm = milliMho per centimeter; meq/L = milliequivalents per liter)

Characteristic	Acceptable limit without treatment required	PGC test results
Electrical conductivity (mMhos/cm)	0.75 for propagation 2.0 for general production	0.20
pH	5.4 to 6.8	8.3
Alkalinity (meq/L)	1.5*	1.9

\*Alkalinity levels from 3 to 8 meq/L may require acid injection to counteract the impact on growing media pH.

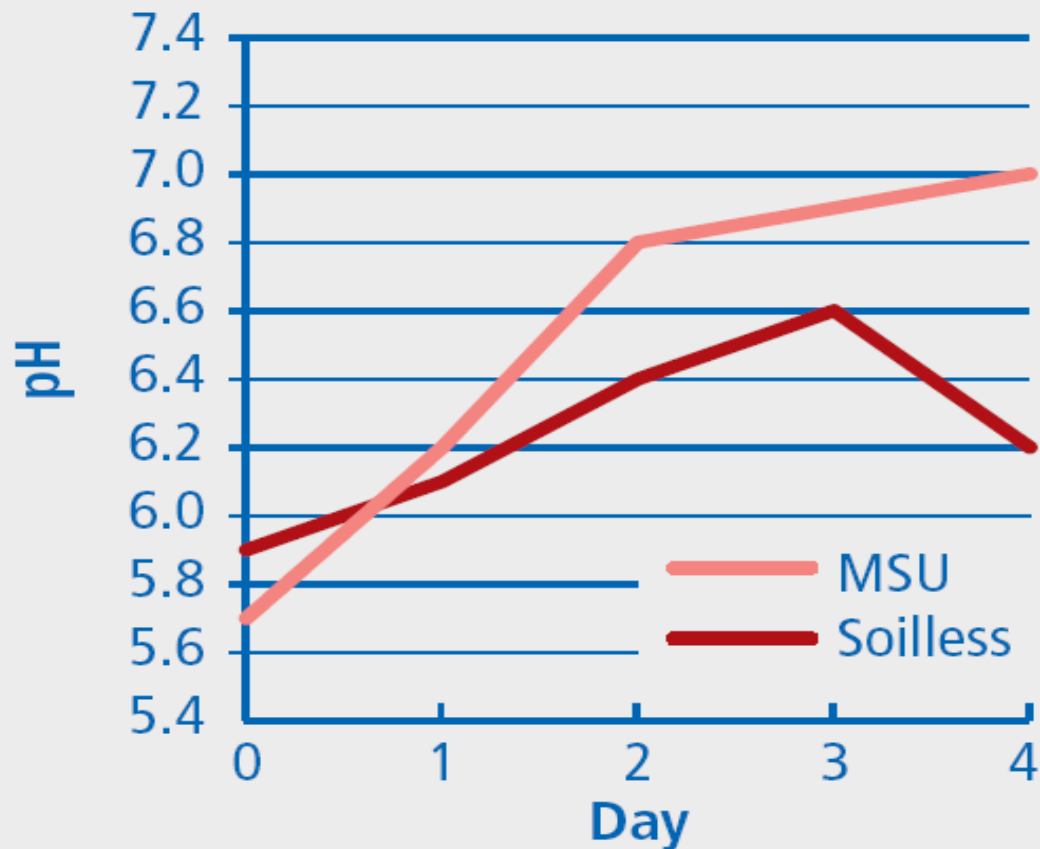
# Alkalinity Treatments

<u>Water Alkalinity</u>	<u>Treatment</u>
< 1.5 me (75 ppm)	No treatment
< 3.0 me (150 ppm)	Acid forming fertilizer and/or less lime in media
<8.0 me (400 ppm)	Acid injection
>8.0 me (400 ppm)	Reverse osmosis



## Media pH in two mixes

Media pH of commercially prepared soilless mix and Montana State University (MSU) prepared mix with daily application of irrigation water

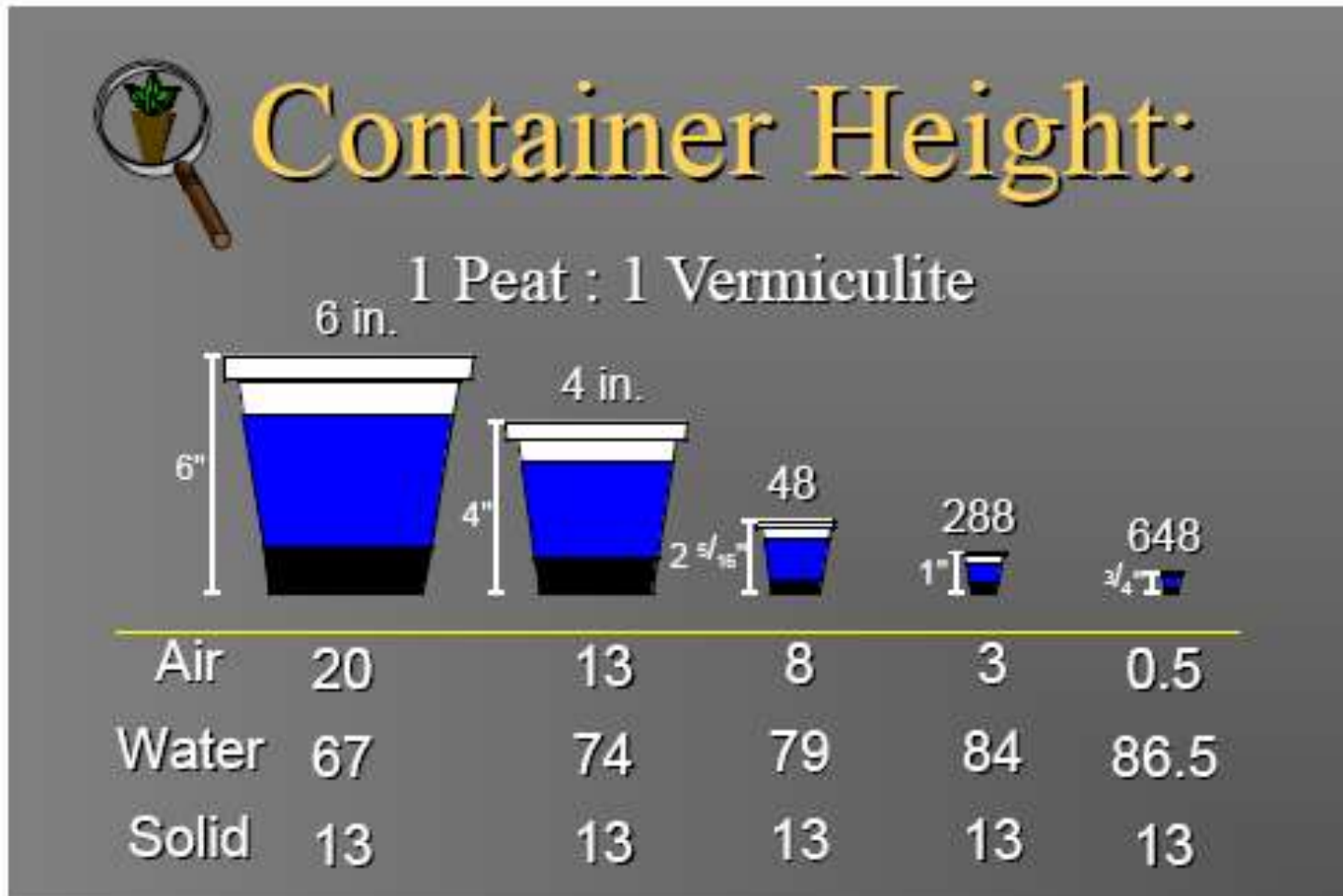


# Functions of Growing Media

- Hold water
- Hold nutrients
- Permit gas exchange to and from roots
- Provide support



# Air : water ratio dependent on container height



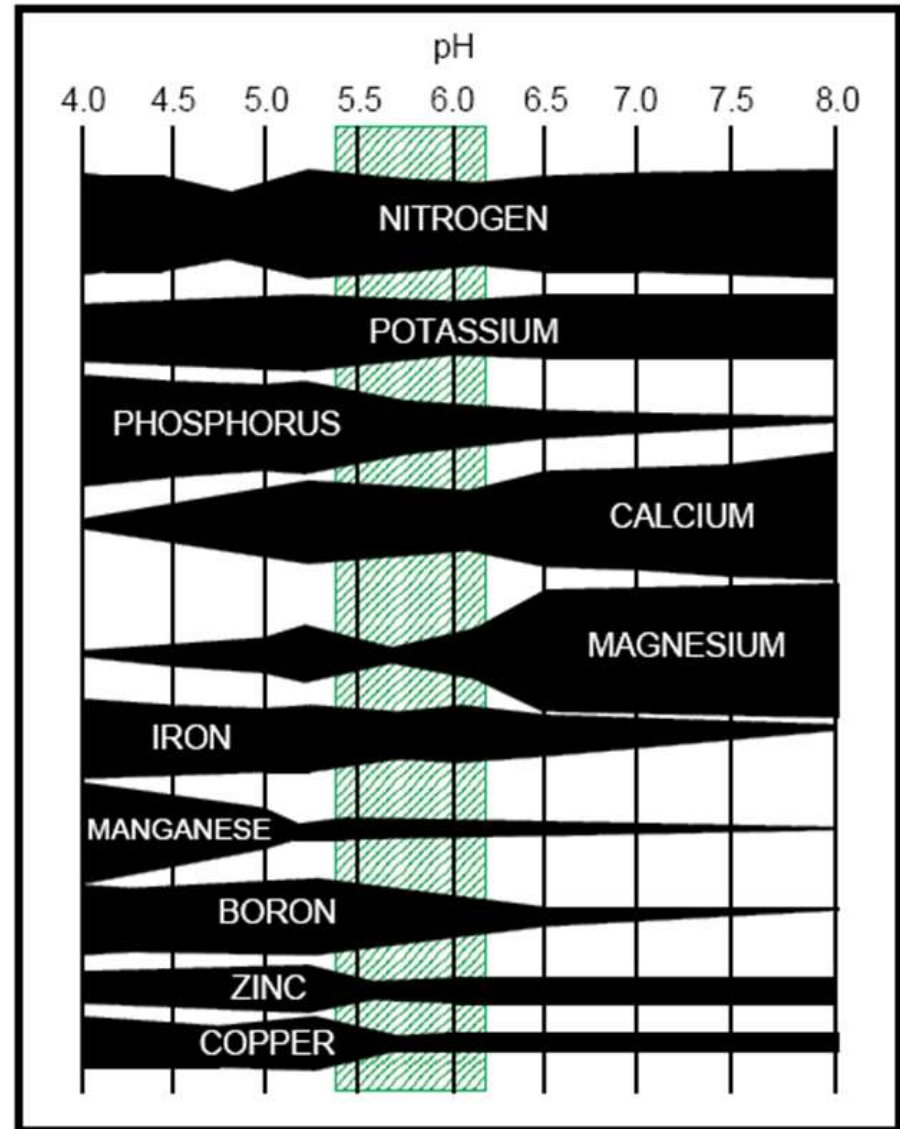
% of container volume at container capacity

Source: NCSU Greenhouse Substrates and Fertilization

# Chemical Properties of Growing Media

## ■ pH

- controls the availability of all essential plant nutrients
- pH range 5.4-6.0 for soil less media
- pH range 6.2-6.8 for soil-based media (20% mineral soil by volume)



# Potting Mix Components

Components that hold nutrients and water:

Peat Moss

Top Soil

Composted Bark

Coir (Coco Fiber)

Vermicompost



# Potting Mix Components

Components that add porosity:

Perlite

Sand

Vermiculite



# MSU Soil Mix vs. Sunshine Mix #1

## ■ MSU Soil Mix

- 1 part Peat Moss:1 part Sand:1 part Topsoil. Aqua-Gro 2000G wetting agent.

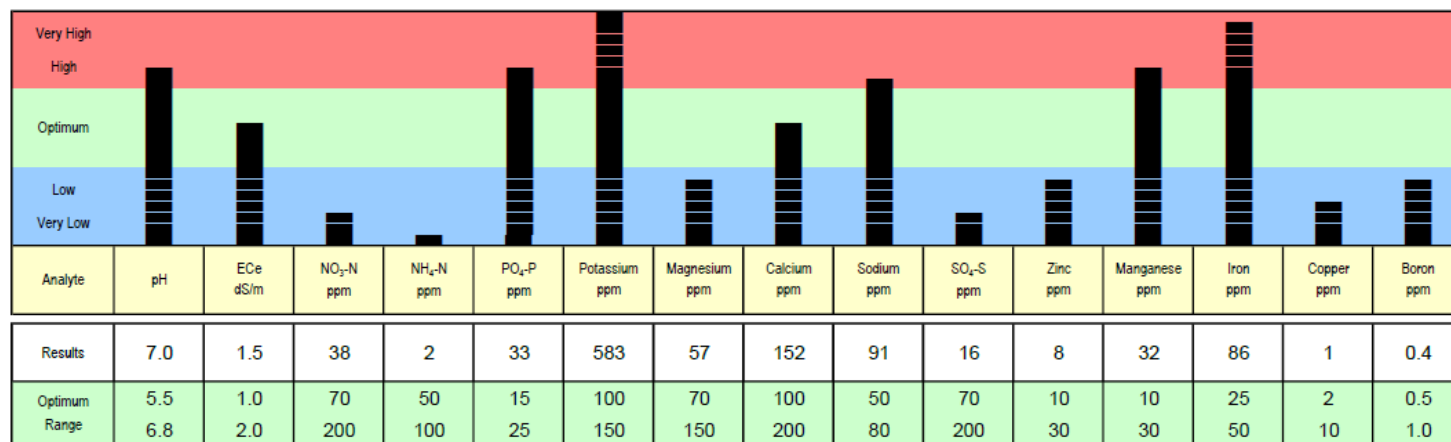
## ■ Sunshine Mix #1

- 3 parts Peat Moss: 1 part Perlite. Wetting agent, dolomitic limestone, Si and starter fertilizer charge

# MSU Mix and Sunshine #1 Mix Test Results

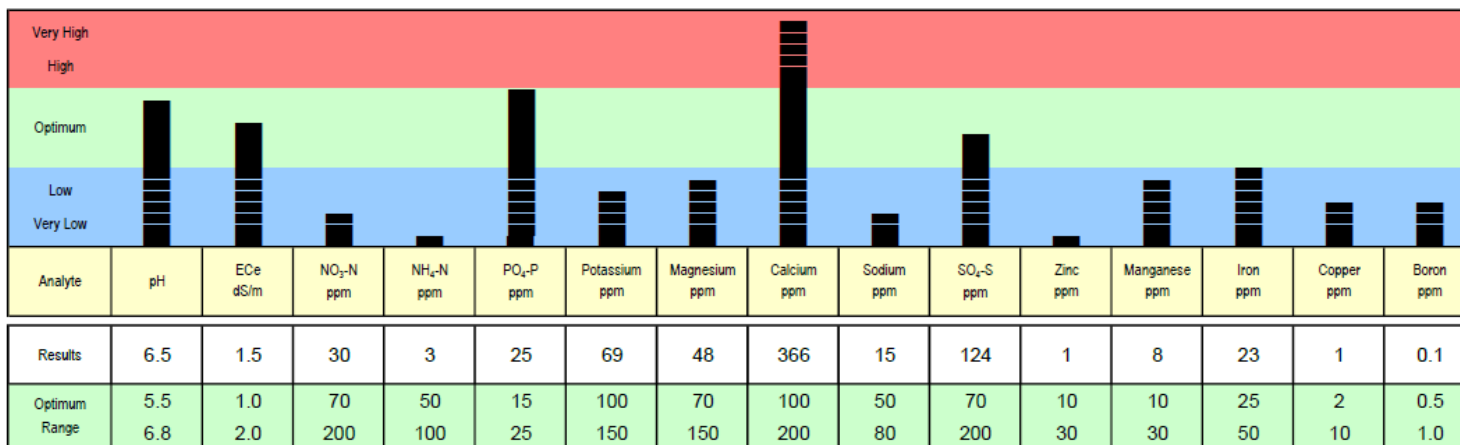
## Container Media Analysis: Modified (DTPA) Saturated Media Extract

DATE OF REPORT: 09/08/15      LAB NO: 57898      SAMPLE ID: MSU      CROP:      PAGE: 1



## Container Media Analysis: Modified (DTPA) Saturated Media Extract

DATE OF REPORT: 08/28/15      LAB NO: 56960      SAMPLE ID: SS#1      CROP:      PAGE: 1





# Selection of Fertilizer

- Proportion of potash (1N:1K<sub>2</sub>O)
- Proportion of phosphate (1N: ½P<sub>2</sub>O<sub>5</sub>)
- Form of nitrogen
  - Ammonium (NH<sub>4</sub><sup>+</sup>)
  - Urea
  - Nitrate (NO<sub>3</sub><sup>-</sup>)

Nitrate nitrogen will tend to have a basic reaction, raising media pH. Ammonium sources of nitrogen will have an acid reaction, lowering media pH.

# N Fertilizer - pH Relationship

Fertilizer	% $\text{NH}_4^+$	Potential Acidity
20-20-20	69	474 lbs.
20-10-20	38	393 lbs.
15-16-17	30	165 lbs.
		Potential Basicity
15.5-0-0	6	400 lbs.
13-0-44	0	460 lbs.

**SUNSHINE**  
**TECHNIGRO**  
**20-10-20 NO BORON**

**For Continuous Liquid Feed Programs - For Professional Use Only**

**GUARANTEED ANALYSIS - USA**

<b>Total Nitrogen (N)</b> .....	<b>20%</b>
8.0 % Ammoniacal Nitrogen	
12.0% Nitrate Nitrogen	
<b>Available Phosphate (P<sub>2</sub>O<sub>5</sub>)</b> .....	<b>10%</b>
<b>Soluble Potash (K<sub>2</sub>O)</b> .....	<b>20%</b>
<b>Magnesium (Mg)</b> .....	<b>0.40%</b>
0.40% Water Soluble Magnesium (Mg)	
<b>Sulfur (S)</b> .....	<b>0.50%</b>
0.50% Combined Sulfur	
<b>Copper (Cu)</b> .....	<b>0.05%</b>
0.05% Chelated Copper (Cu)	
<b>Iron (Fe)</b> .....	<b>0.10%</b>
0.10% Chelated Iron (Fe)	
<b>Manganese (Mn)</b> .....	<b>0.05%</b>
0.05% Chelated Manganese (Mn)	
<b>Molybdenum (Mo)</b> .....	<b>0.01%</b>
<b>Zinc (Zn)</b> .....	<b>0.05%</b>
0.05% Chelated Zinc (Zn)	

DERIVED FROM: Ammonium Phosphate, Potassium Nitrate, Ammonium Nitrate, Magnesium Sulfate, Iron EDTA, Copper EDTA, Zinc EDTA, Manganese EDTA, Boric Acid, Sodium Molybdate.

POTENTIAL ACIDITY: 400 lb Calcium Carbonate Equivalent per ton.

NET WEIGHT: 25 lb / 11.3 kg

**WARNING:** This fertilizer contains Molybdenum. Its use on forage crops may result in crops containing levels of molybdenum which are toxic to ruminants.

Information regarding the contents and levels of metals in this product is available on the Internet at: <http://www.aapfco.org/metals.htm>

**DIRECTIONS FOR USING 20-10-20 NO BORON**

**Mixing Concentrated Fertilizer Solutions:**  
 The table below lists how much Technigro fertilizer by weight to blend into a given volume of water to make a concentrated fertilizer solution. Recommended fertilizer concentrations are for a continuous feed program. However, the Technigro formula (NPK) and concentration (ppm) most suitable for individual use should be determined by soil and water analysis as well as plant response. Various target concentration and common injector ratios are included. Technigro dissolves faster in hot water. When mixing a concentrated solution with cold water, stir well and allow ample time for fertilizer to dissolve before using.

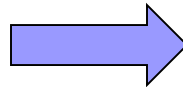
**20-10-20 NO BORON fertilizer required in concentrate solution**

Injector Ratio	50 ppm Nitrogen	100 ppm Nitrogen	200 ppm Nitrogen
No Dilution	0.03 oz/gal (0.25 g/l)	0.07 oz/gal (0.5 g/l)	0.13 oz/gal (1 g/l)
<b>1:15 (Hozen)</b>	0.5 oz/gal (3.8 g/l)	1 oz/gal (7.5 g/l)	2 oz/gal (15 g/l)
<b>1:50</b>	1.7 oz/gal (12.5 g/l)	3.4 oz/gal (25 g/l)	6.7 oz/gal (50 g/l)
<b>1:100</b>	3.4 oz/gal (25 g/l)	6.7 oz/gal (50 g/l)	13.4 oz/gal (100 g/l)
<b>1:128</b>	4.5 oz/gal (32 g/l)	8.5 oz/gal (64 g/l)	17 oz/gal (128 g/l)
<b>1:200</b>	6.7 oz/gal (50 g/l)	13.4 oz/gal (100 g/l)	26.7 oz/gal (200 g/l)

A soluble salts or conductivity meter can be used to estimate the concentration of fertilizer solutions. The correct conductivity (EC) in mmhos/cm is listed below for various ppm Nitrogen concentrations. When measuring the conductivity of fertilizer solutions, be sure to subtract the conductivity of the water from the measured value of the fertilizer solution.

50 ppm Nitrogen	100 ppm Nitrogen	150 ppm Nitrogen	200 ppm Nitrogen	300 ppm Nitrogen
<b>0.35</b>	<b>0.65</b>	<b>0.98</b>	<b>1.30</b>	<b>1.95</b>

Potential  
 Acidity: 400  
 lbs. Calcium  
 Carbonate  
 Equivalent per  
 ton



# Miracle-Gro – Acid or Base Forming?

## Miracle-Gro® Water Soluble All Purpose Plant Food 24-8-16

### GUARANTEED ANALYSIS

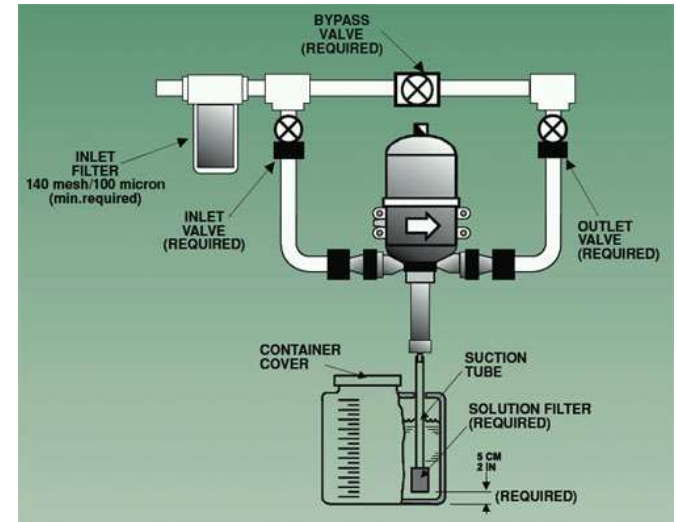
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Total Nitrogen (N) .....	24%	Molybdenum (Mo) .....	0.0005%
3.5% Ammoniacal Nitrogen		Zinc (Zn) .....	0.06%
20.5% Urea Nitrogen		0.06% Water Soluble Zinc (Zn)	
Available Phosphate (P <sub>2</sub> O <sub>5</sub> ) .....	8%	Derived from Ammonium Sulfate,	
Soluble Potash (K <sub>2</sub> O) .....	16%	Potassium Phosphate, Potassium Chloride,	
Boron (B) .....	0.02%	Urea, Urea Phosphate, Boric Acid, Copper	
Copper (Cu) .....	0.07%	Sulfate, Iron EDTA, Manganese EDTA,	
0.07% Water Soluble Copper (Cu)		Sodium Molybdate, and Zinc Sulfate.	
Iron (Fe) .....	0.15%	Information regarding the contents and	
0.15% Chelated Iron (Fe)		levels of metals in this product is available	
Manganese (Mn) .....	0.05%	on the Internet at	
0.05% Chelated Manganese (Mn)		<a href="http://www.regulatory-info-sc.com">http://www.regulatory-info-sc.com</a>	

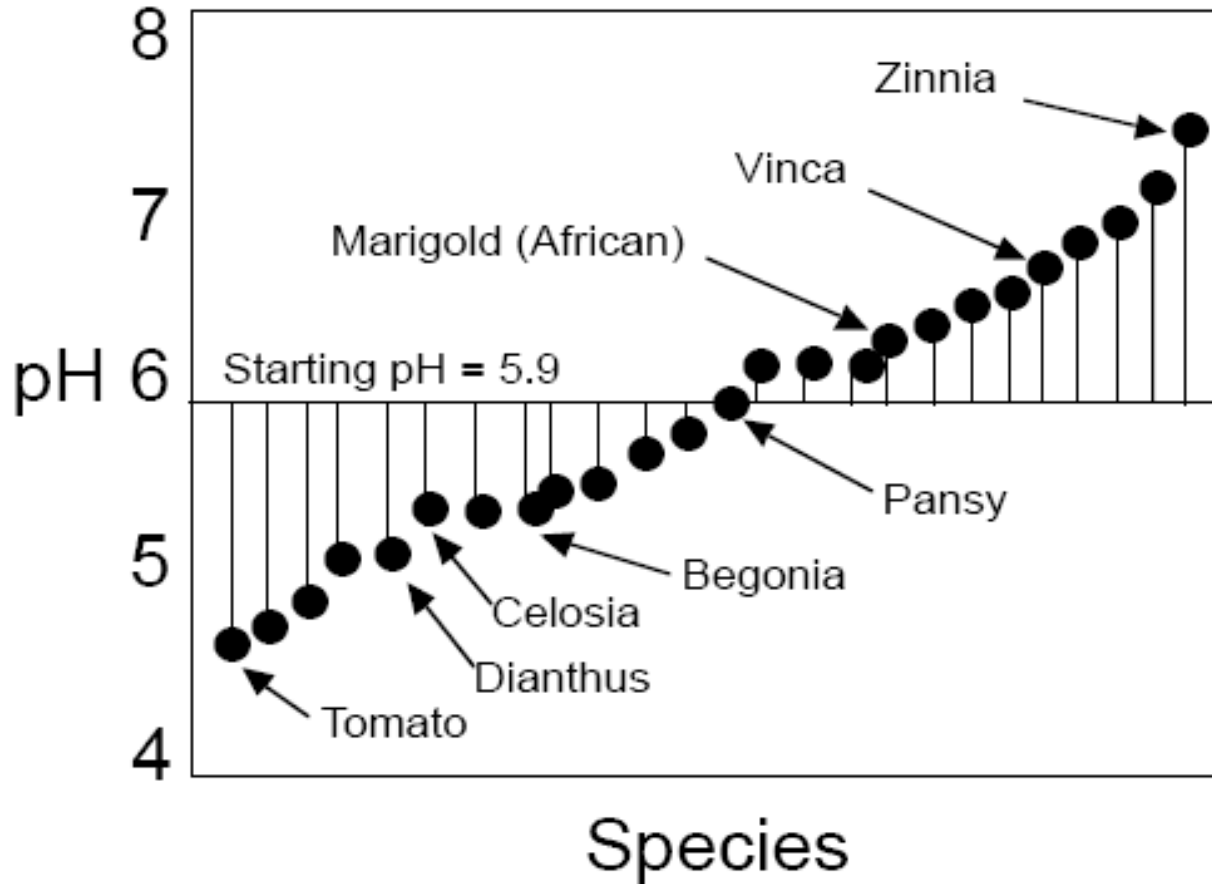
# Fertilizer Injection



# Fertilizer Injectors



# Species Effect on pH



Source: NCSU – Greenhouse Substrates and Fertilization

# The “Big Four” Nutritional Problems

## ■ Too High pH

- Caused by highly alkaline water, excess lime, calcium nitrate fertilizers.
- P, Fe, Mn, Zn, Cu, and B tied up.

## ■ Too Low pH

- Caused by acid forming fertilizers ( $\text{NH}_4^+$ )
- Ca, Mg, S, Mo tied up. Excessively soluble Fe, Mn, and Al react with P to render it insoluble.





# The “Big Four” continued

- **Excess Soluble Salts**

- Caused by a combination of high salinity water and excess fertilization

- **Low Soluble Salts**

- Caused by excessive leaching, infrequent fertilization and/or malfunctioning fertilizer injector



What happens when you confuse 17-17-17 Lawn and Garden fertilizer with 17-17-17 “time release” fertilizer.

# The Pour Through Test



Figure 2a. Irrigate containers thoroughly.



Figure 2e. Collected leachate for testing.



Figure 2f. Collect 50 ml (1.5 ounces) for testing.



Figure 2b. Saucer for pots.



Figure 2c. Saucers for cell packs.



Figure 2g. Calibration standards for testing.

Table 1. Amount of water to apply to various containers to obtain 50 ml (1.5 ounces) of extract\*.

Container Size	Water to add**	
	milliliters	ounces
4 inch		
5 inch	75	2.5
6 inch		
6.5 inch azalea	100	3.5
1 quart	75	2.5
4 quart	150	5.0
12 quart	350	12.0
Flats		
606 (36 plants)	50	2.0
1203 (36 plants)		
1204 (48 plants)		

\*Containers should be brought to container capacity 30 to 60 minutes before applying these amounts.  
 \*\*These amounts are estimates. Actual amounts will vary depending on crop, substrate type, and environmental conditions.



Figure 2d. Applying water for extraction.



Figure 2h. Testing leachate samples.

# EC interpretation values for Pour Through

Pour Through (mS/cm)	Indication
0 to 1.0	Very Low
1.0 to 2.6	Low
2.6 to 4.6	Normal
6.6 to 7.8	Very High
> 7.8	Extreme
Adapted from BC Ministry of Agriculture	

All this and more may be found on the PGC website:

[ag.montana.edu/plantgrowth](http://ag.montana.edu/plantgrowth)