Planning a Greenhouse Fertilization Program: Challenges in Plant Fertilization

Neil Mattson

Assistant Professor, Floriculture

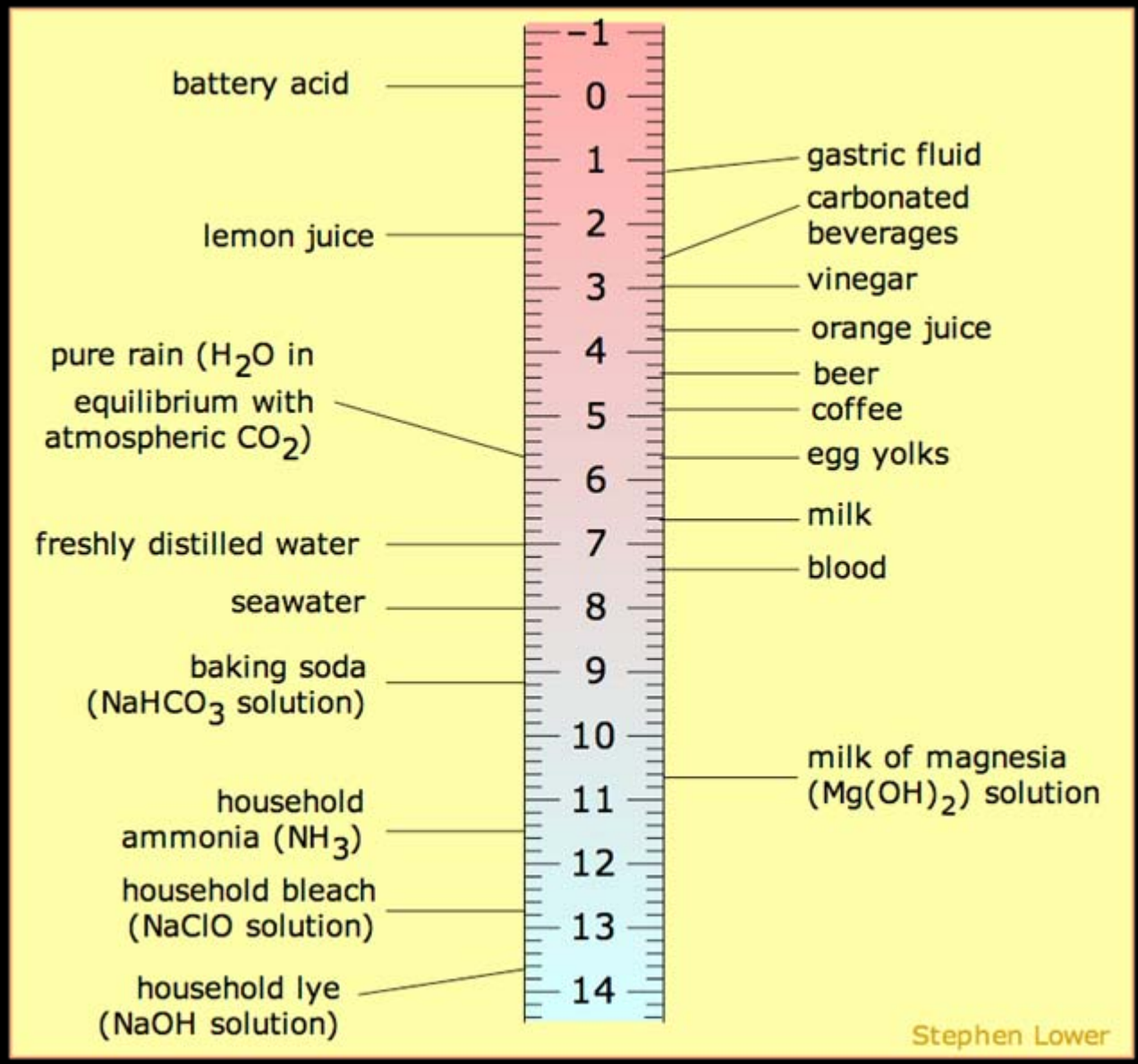
Department of Horticulture, Cornell University

nsm47@cornell.edu

Outline

- pH control
- Alkalinity and control with acid injection
- How to interpret water/media tests
- Visual diagnosis of nutrient disorders
- Fertilizer adjustments when growing plants cooler
- Using controlled release fertilizers
- Pour-Thru –to measure media EC and pH

What is pH? Why should we care?



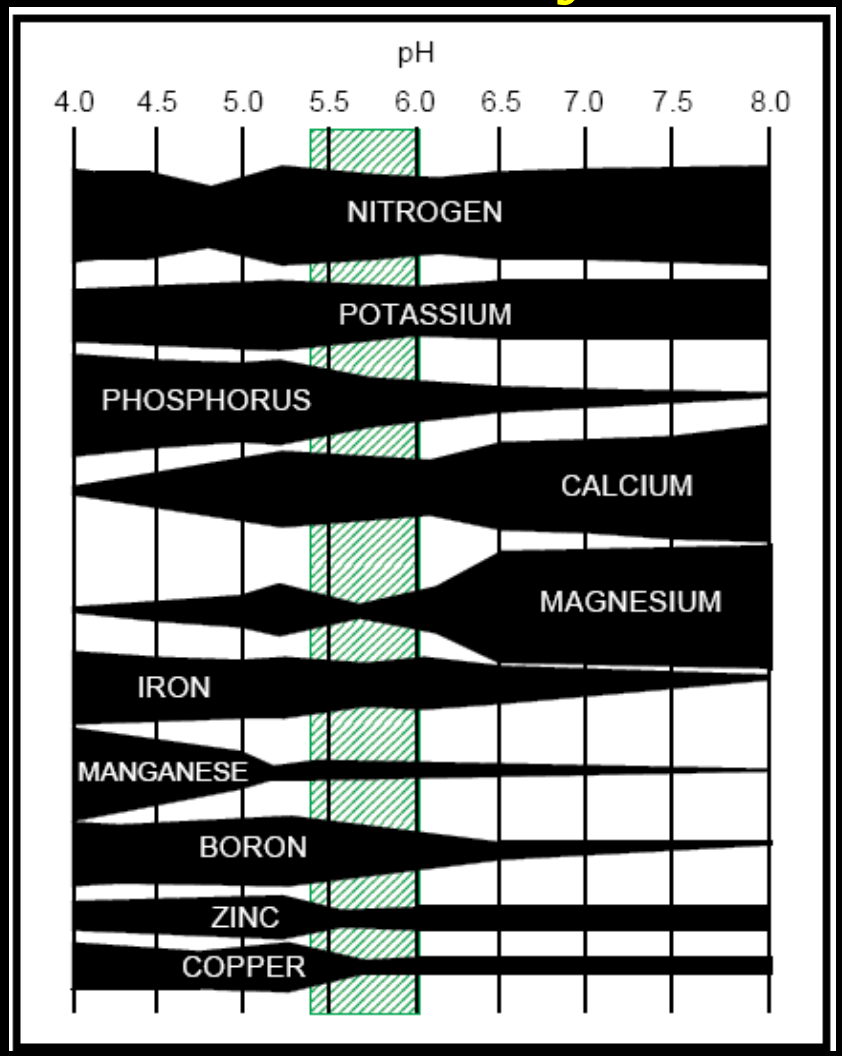
Source: S. Lower, http://en.wikipedia.org/wiki/Image:PH_scale.png

Why do we care about pH?

Half of all nutritional disorders associated with container plant production can be attributed to pH-related problems

pH affects nutrient solubility (roots can only take up dissolved nutrients)

Effect of pH on container media nutrient availability



Source: Douglas Bailey
http://www.ces.ncsu.edu/depts/hort/floriculture/plugs/alkalinity.pdf

pH Problems

pH too low:

- Toxicity of Iron, Manganese, Zinc, Copper
- Deficiency of Calcium, Magnesium
- Leaching of phosphorus

pH too high:

- Deficiency of Iron, Manganese, Zinc, Copper, Boron
- may promote spread of certain diseases (ex: for *Thielaviopsis* keep pH less than 6.0)

Factors that affect the pH of the root media:

- the media that is used
  - acidic media (pH less than 7): sphagnum peat moss, pine bark, coir, many composts
  - neutral media (pH around 7): perlite, sand, polystyrene
  - alkaline media (pH greater than 7): bark from hardwood trees, vermiculite, rockwool, rice hulls
- Limestone/Dolomite additions to container media

Factors that affect the pH of the root media:

- the alkalinity of the water - carbonates/bicarbonates which will increase the pH of the container media over time
- fertilizers that are used
  - ammonium or urea based fertilized tend to acidify the root media
  - nitrate based fertilized tend to increase the root media pH

What is Optimal pH?

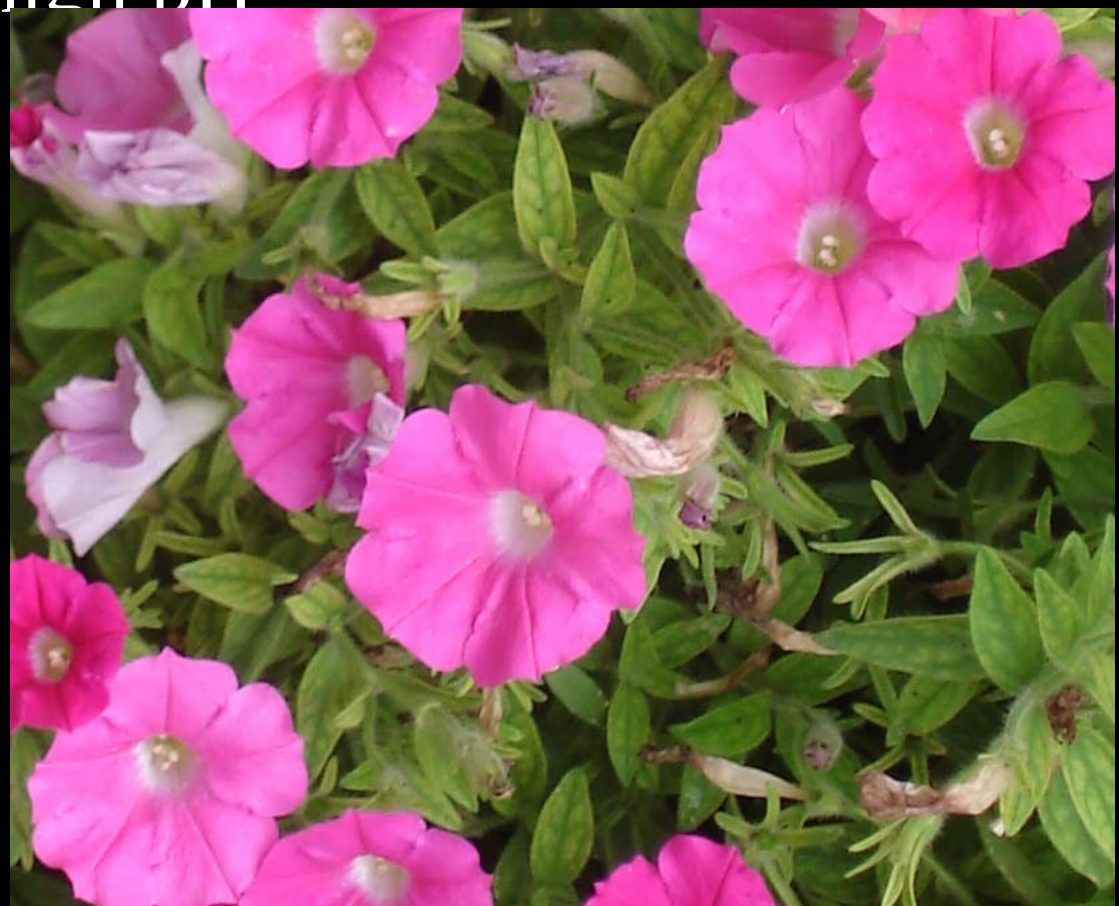
In General: 5.4 to 6.4

Can further break down based on efficiency of taking up micronutrients

What is Optimal pH?

Iron-inefficient group (Petunia group)

- require a lower pH (5.4-6.0)
- Iron deficiency at high pH



What is Optimal pH?

General group

- require a moderate pH (5.8-6.4)
  - Most plants, chrysanthemum, poinsettia

What is Optimal pH?

Iron-efficient group (Geranium group)

- Require a higher pH 6.0-6.6
- Iron/Manganese toxicity at low pH (bronze speckle)

Image source: Tina Smith, UMass

Ways to Lower pH

- Gradual methods:
  - Use an ammonium or urea based fertilizer
  - Continual acid injection to decrease water alkalinity to 120 ppm
- Quick methods:
  - One-time sulfuric acid drench (1.8 ounces sulfuric acid / 100 gallons of water)

Ways to Raise pH

- Gradual methods:
  - Stop acidifying water if acid is being injected
  - Use a nitrate based fertilizer (basicity)
- Quick methods:
  - Flowable lime or Potassium bicarbonate drench (see handout for tips)

Understanding Alkalinity

Alkalinity – the ability of water to neutralize acids

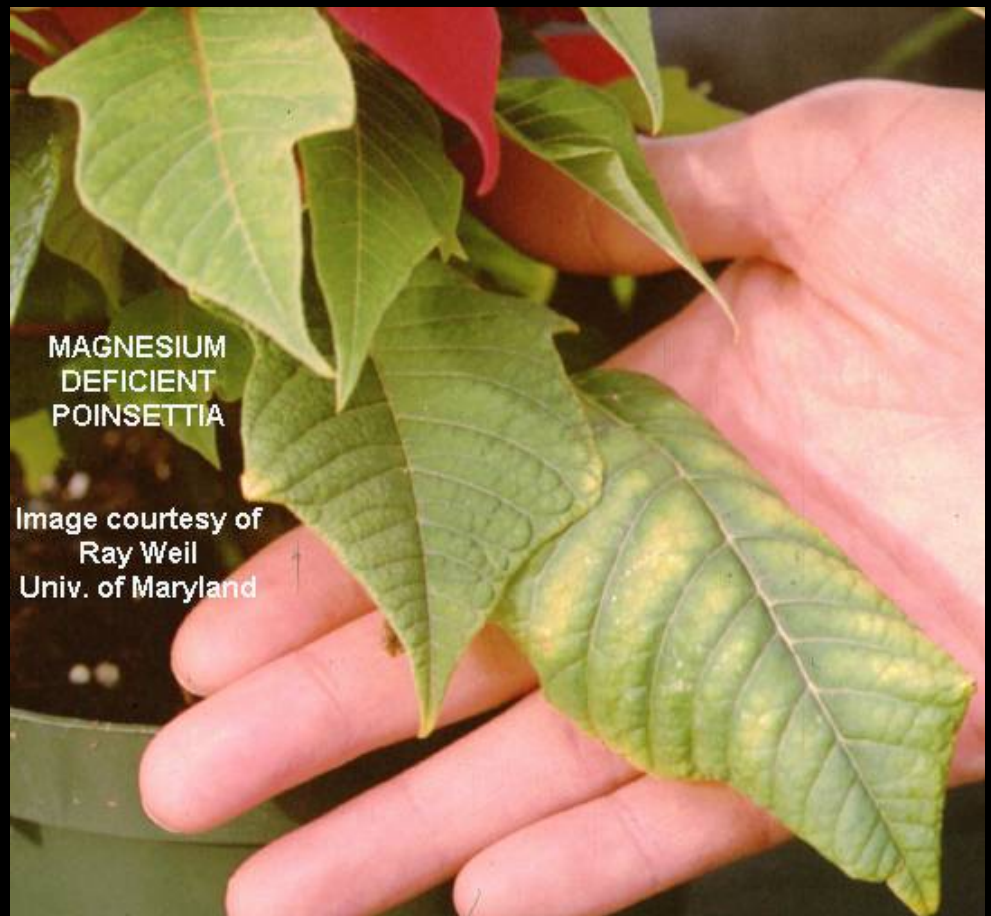
- due to the presence of dissolved alkalis
- Do not confuse with “Alkaline”
- Reported in terms of ppm $CaCO_3$ (or meq; 50 ppm = 1 meq $CaCO_3$)
- Typically varies from 50-500 ppm

What is Optimal Alkalinity?

	Optimal	Concern
Plugs	60-100	<40, >120
Flats/Small Pots	80-120	<40, >140
Large containers (>6”)	120-180	<60, >200

Problems with High Alkalinity

- Rapid media pH rise
- Magnesium deficiency (interveinal chlorosis of lower leaves)



Problems with Low Alkalinity

- pH of container media will change more rapidly
- Calcium deficiency
- Low pH induced Iron/Manganese Toxicity

Correcting High Alkalinity

1) Change or blend the water source
2) Use an acidic fertilizer
3) Inject acid into irrigation water

Guidelines for matching fertilizer acidity with water alkalinity to achieve a stable pH

Alkalinity Concentration (in ppm $CaCO_3$)	CCE (in lbs./ton)	% Acidic Nitrogen	Examples
250 – 300	>500 acidic	>50%	20-20-20 21-7-7
150 – 250	200 acidic – 450 acidic	40%	20-10-20 21-5-20
60 – 150	150 acidic – 150 basicc	20% - 30%	17-5-17 20-0-20
30 – 60	> 200 basic	<10%	13-2-13 14-0-14

[1]% acidic nitrogen is calculated as the sum of ammoniacal and urea nitrogen divided by the total nitrogen contained in the formula

Source: Paul Fisher and William Argo, http://extension.unh.edu/agric/AGGHFL/pHarticl.pdf

Fertilizer Selection by Water Type

Select Water Type

Select CONTINUE

Don't know your water type?

WATER TYPE	ALKALINITY	CALCIUM	MAGNESIUM
1	Very low: 0-60 ppm	0-60 ppm	0-30 ppm
2	Moderately Low: 60-150 ppm	0-60 ppm	0-30 ppm
3	Moderately High: 150-200 ppm	50+ ppm	0-30 ppm
4	Very High: 200-240+ ppm	50+ ppm	0-30 ppm

Example from: http://petersabc.com/

Factors when using fertilizer to adjust pH

- The fertilizer approach does not work well in dark/cool weather
- Sometimes ammonium will not drop pH – high lime in media, high alkalinity

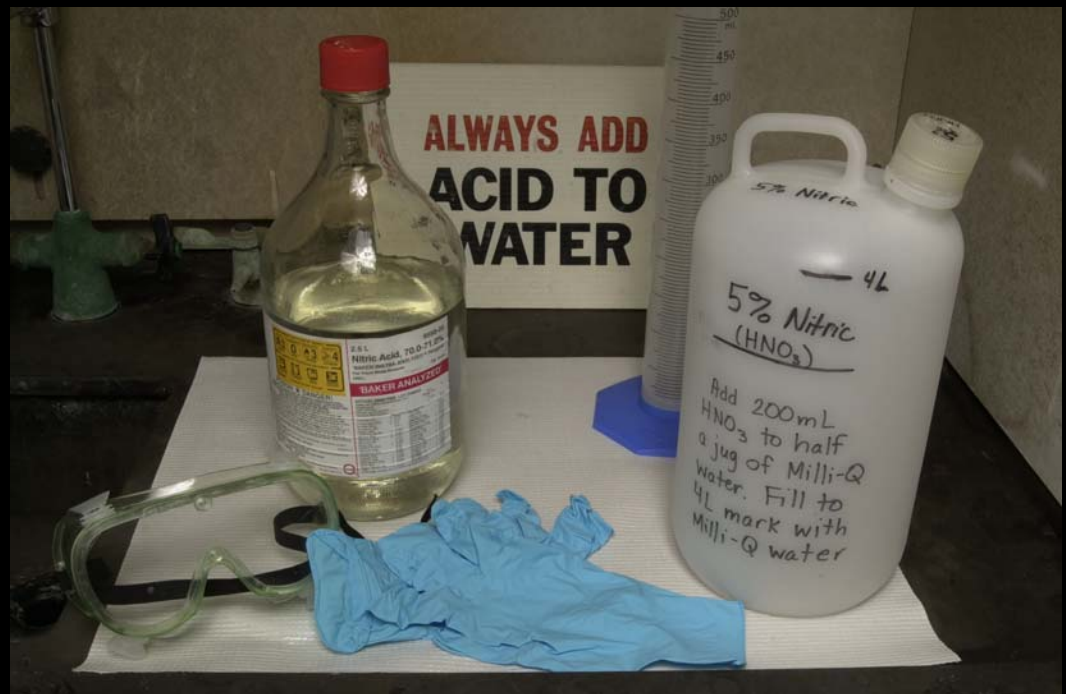
Acid Injection

Acidification reduces the amount of carbonates and bicarbonates

H^+ (from acid) + HCO_3^- (in water) → $CO_2 + H_2O$

Which Acid to Use?

- Safety
  - Nitric acid is very caustic and has harmful fumes
- Cost
- Nutrients from Acid



Acid Injection Tips

- Do not mix acid stock solutions with fertilizer stock solutions
- Use a separate injector
- May take a week of acid injection to stabilize (initially acid may react with hard water accumulation in pipes)
- Online acid calculator:

http://www.ces.ncsu.edu/depts/hort/floriculture/software/alk.html

How to use a soil/water test to look for problems:

1) Look at **EC -** electrical conductivity (also called soluble salt level)

- to raise EC: increase concentration of fertilizer
- to lower EC: leach with clear water; lower fertilizer concentration

2) Look at **pH**

- To lower pH…
- To raise pH…

3.) Look at **macronutrients** levels

4. Look at **micronutrient** levels

- To solve a micronutrient deficiency:
- check media pH
- liquid application with micronutrient fertilizer
- use a complete fertilizer that contains micronutrients

5.) Two **ratios** to look at:

- Calcium:Magnesium (this should be about 3:1) if there is too much magnesium the plant will have a hard time taking up calcium and etc.

- Nitrate:Potassium (this should also be 3:1)

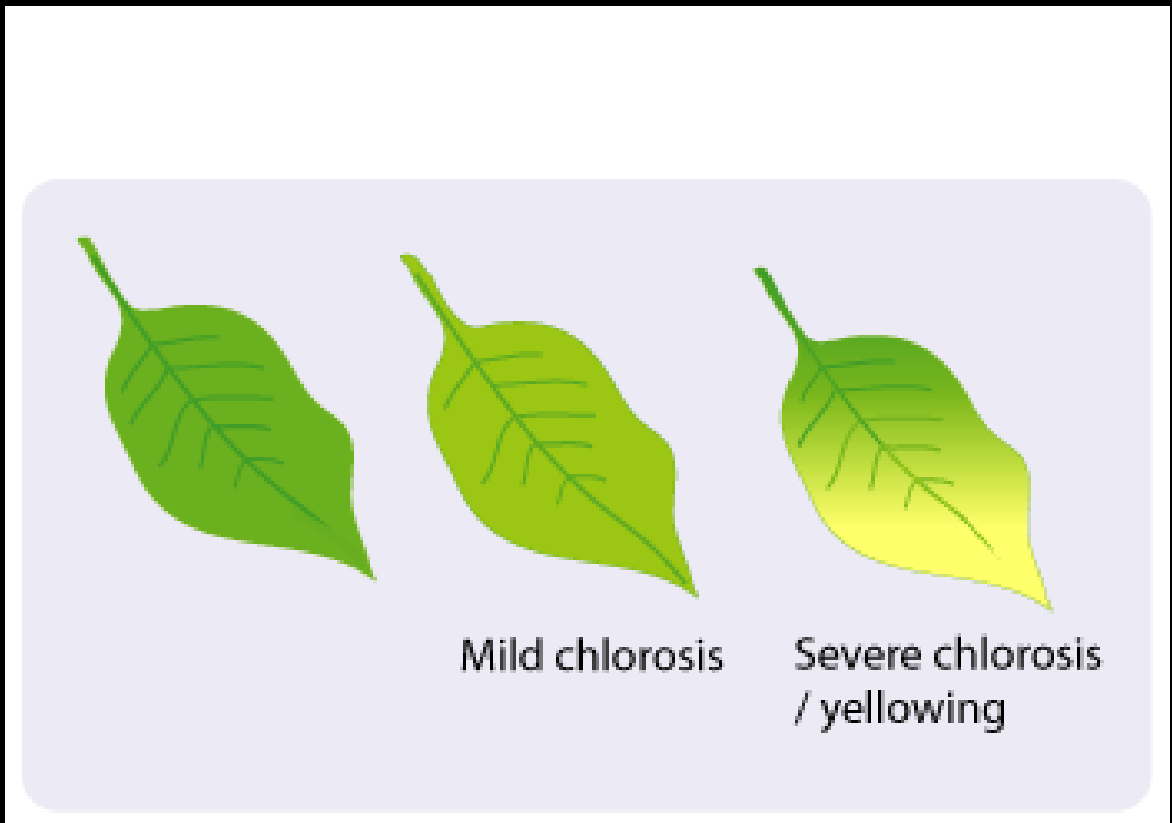
Some other causes of fertility problems

- poor weather (example low temperature can cause **ammonium toxicity**)
- poor drainage of container
- over/under watering
- poor light
- poor water quality

Visual Diagnosis of Nutrient Disorders

Definitions

- Chlorosis – yellowing of plant tissue (due to reduction in chlorophyll)



Common Nutrient Disorders

Definitions

- Necrosis – death (browning) of plant tissue

Common Nutrient Disorders

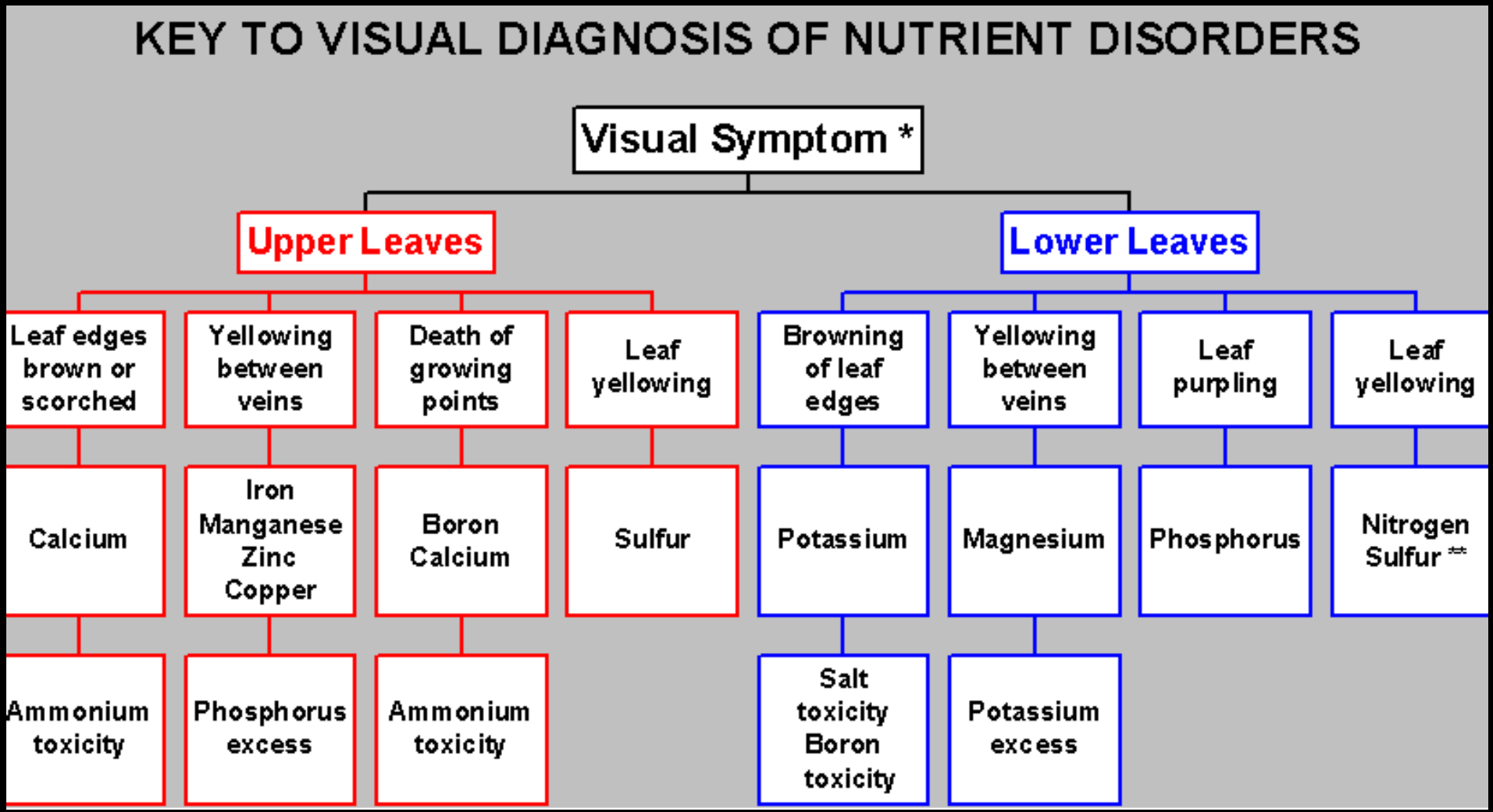
Definitions

- Interveinal - the region between the veins

Common Nutrient Disorders

Definitions

- Margins – the edges of the leaf



Source: Bierman and Rosen, http://www.extension.umn.edu/distribution/horticulture/M1190.html

Using Visual Diagnosis

- Notice that many nutrient disorders look alike – media or tissue testing may be required to confirm disorder
- Remember that other factors (pH, nutrient antagonisms) can affect nutrient availability

Fertilizer Adjustments When Growing Plants Cooler

Problems Associated with Growing Cooler

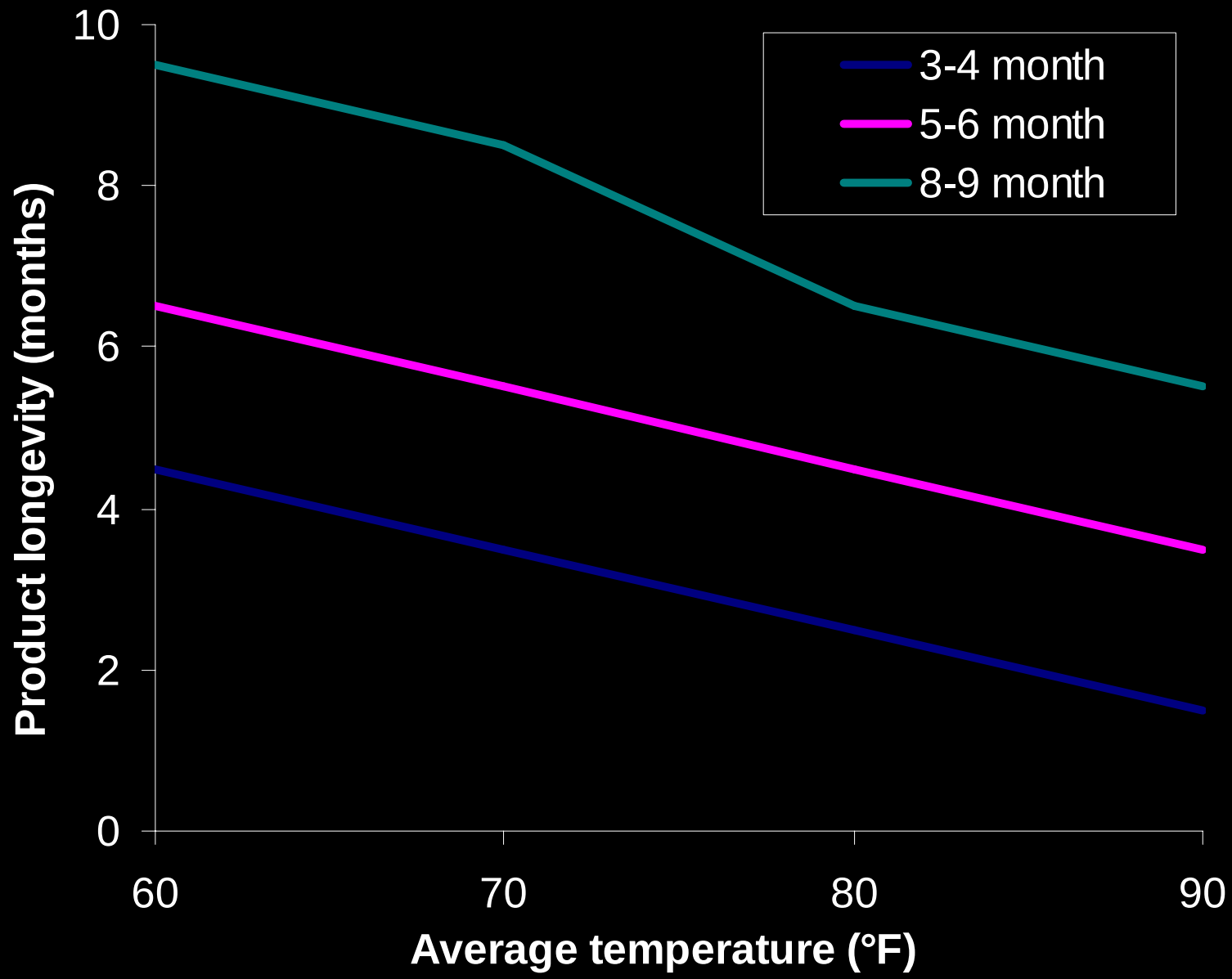
- Phosphorus deficiency below 55 °F
- Inactive roots at low media temperatures
  - Wilting even though media wet
  - Calcium deficiency
- Ammonium toxicity
  - Below 60 °F ammonium not converted to nitrate

What adjustments can you make?

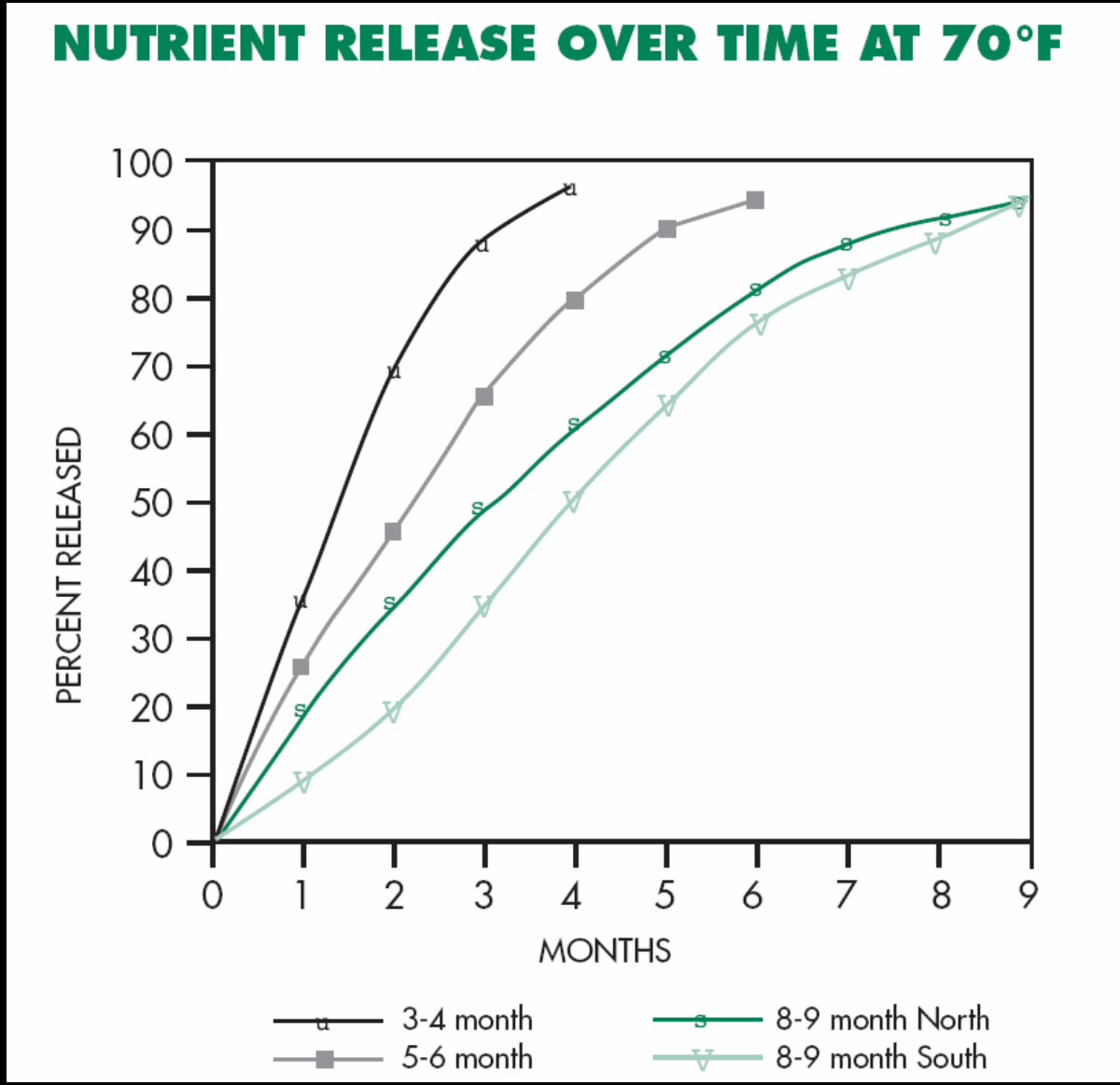
- Young plants are most sensitive
- During propagation/germination keep at 60-65 °F
- Switch to nitrate-based fertilizer
  - 15-0-15 dark weather feed (11% Ca)
  - 15-5-15 Cal-Mag (5% Ca, 2% Mg)

Controlled Release Fertilizers

Temperature controls rate of release



Release Rate by Product



Source: http://www.scottsprohort.com/_documents/tech_sheets/H5124OsmocotePlus.pdf

CRF Application Rates – General Guidelines

- Low (3-4 lbs/cubic yard)
  - salt sensitive, tender plants
  - when soil is used in potting mix
  - if used in combination with a liquid feed program
  - if minimal leaching takes place

CRF Application Rates – General Guidelines

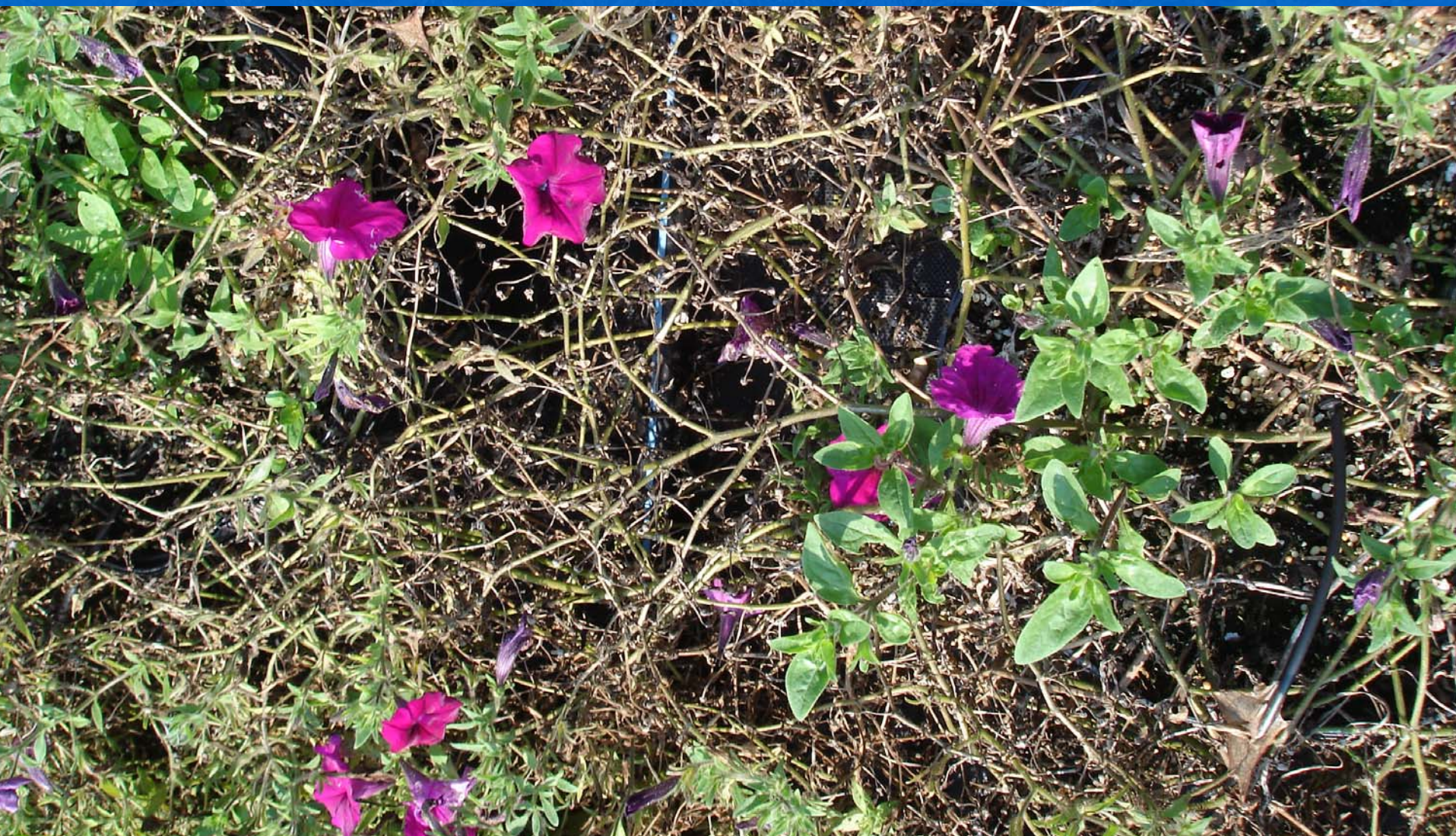
- Medium (5-6 lbs per cubic yard)
  - More vigorous species and heavy feeders (trailing petunias)
  - When there is frequent leaching

Combination Programs

When to combine Controlled Release Fertilizers and Water Soluble Fertilizers (WSF)?

- Simplify the fertilization program
- CRF can provide a base feed with a lower leaching potential
- CRF continues after plants leave the greenhouse – ideal for hanging baskets

Many consumers forget to fertilize containers and hanging baskets after they bring the product home…



Chrysanthemum CRF/WSF Experiment

Cultivar ‘Coparo’

CRF Only

2 wks WSF

4 wks WSF

6 wks WSF

CRF + WSF

WSF Only

Osmocote Plus 8-9 Month

Source: Mark Bridgen

Pour Thru

- Simple technique for measuring pH and EC
- Nondestructive
- Use on each important crop Sample periodically (ideally every 1-2 weeks)
- Take 5 samples per crop each time and average this

For more information and for crop guidelines see: http://www.pourthruinfo.com from NCSU

Crop Zonal Geraniums

Starting Date (week 0) Feb. 15

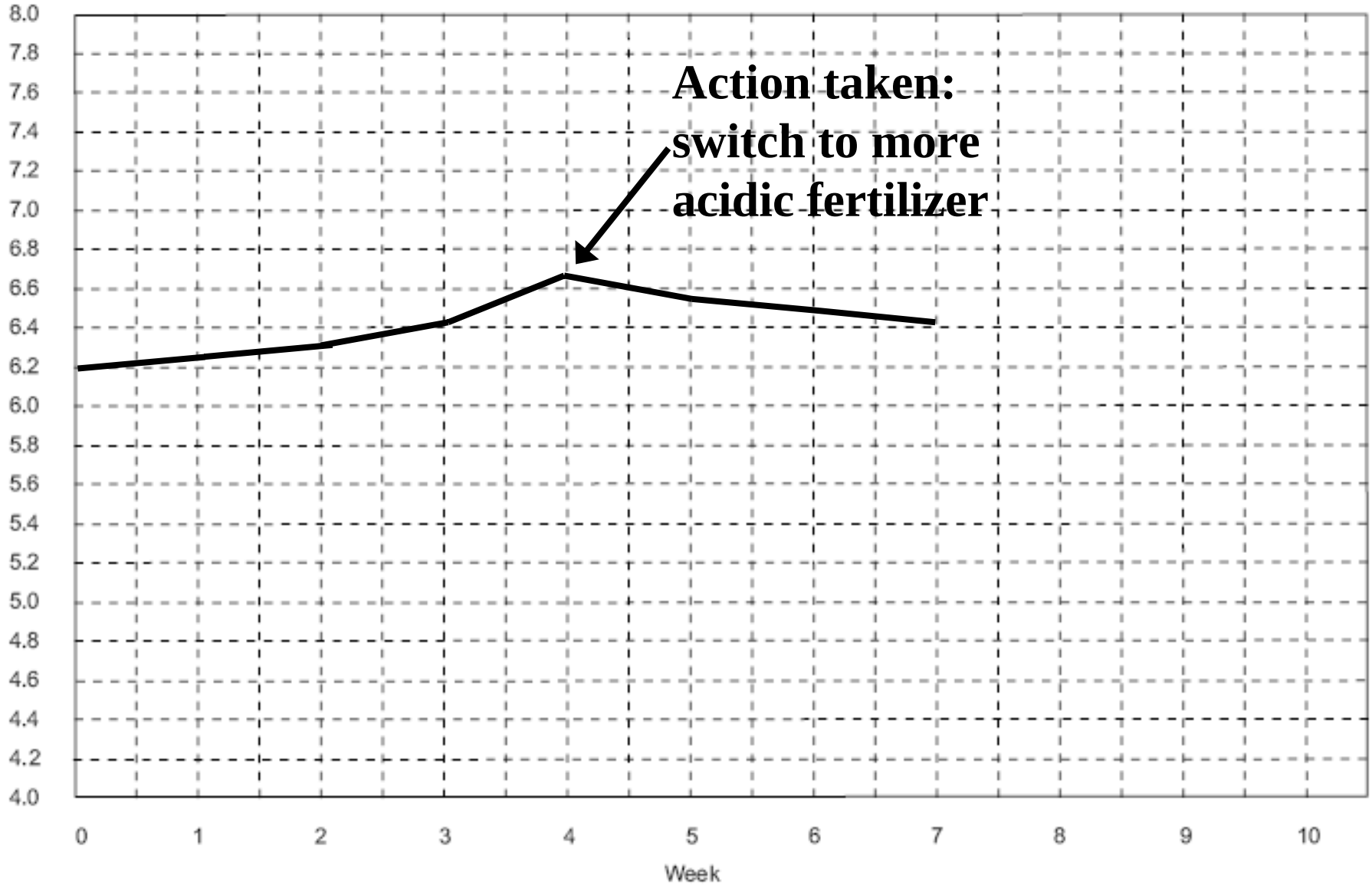
Ending Date _____

Target pH Range 6.0-6.6

Upper pH Decision Range 6.6

Lower pH Decision Range 6.2

PourThru pH Chart (10 Weeks)



General Pour Thru Guidelines for Nursery Crops

Crop	pH	EC
Sensitive plants liquid feed	5.2 – 6.2	0.5 – 0.75
General liquid feed	5.2 – 6.2	0.75 – 1.5
General Controlled Release	5.2 – 6.2	0.2 – 1.0

Source: http://pubs.caes.uga.edu/caespubs/horticulture/solublesalts.html

Neil Mattson
nsm47@cornell.edu
(607) 273-0184
http://www.greenhouse.cornell.edu