Importance of Water Quality: pH, buffering, and effects on nutrient availability

Andrew G. Ristvey

UNIVERSITY OF MARYLAND EXTENSION

The University of Maryland Extension programs are open to any person and will not discriminate against anyone because of race, age, sex, color, sexual orientation, physical or mental disability, religion, ancestry, national origin, marital status, genetic information, political affiliation, and gender identity or expression.

Making the Plant Happy

Objectives for this topic include:

- What you should know before fertilizing – water quality
- pH affect on nutrient availability
- Other elements in the water
- Fertilizer affect on pH

Factors that affect nutrient uptake

Where monitoring should start

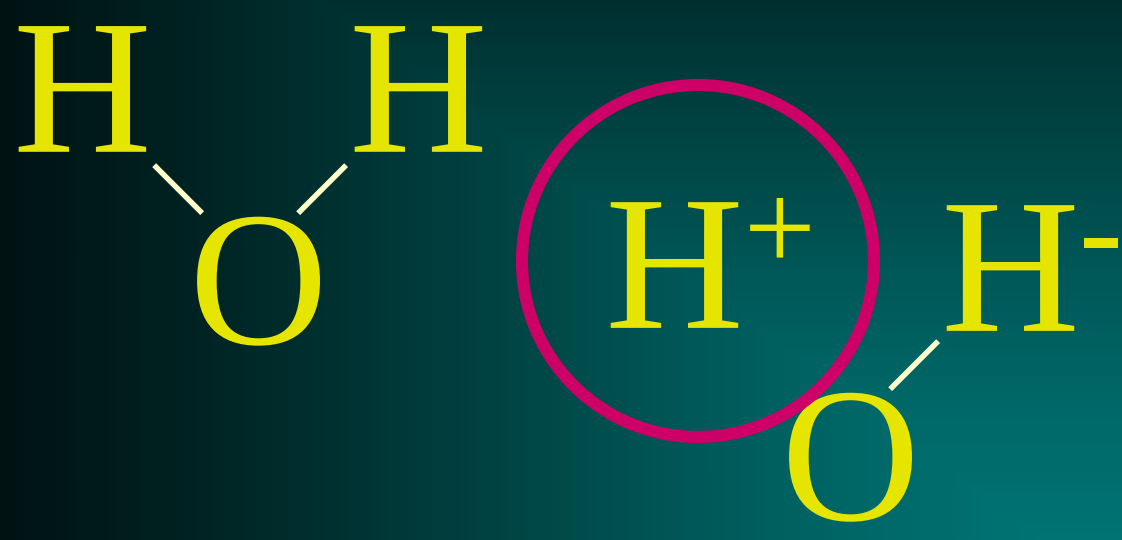
- What factors affect nutrient availability
  - water quality
  - pH
- Getting nutrients to the plant roots
  - Irrigation management - nutrients are water soluble

Water Quality

* pH and the effects on micros
* water quality and alkalinity

pH

H_2O



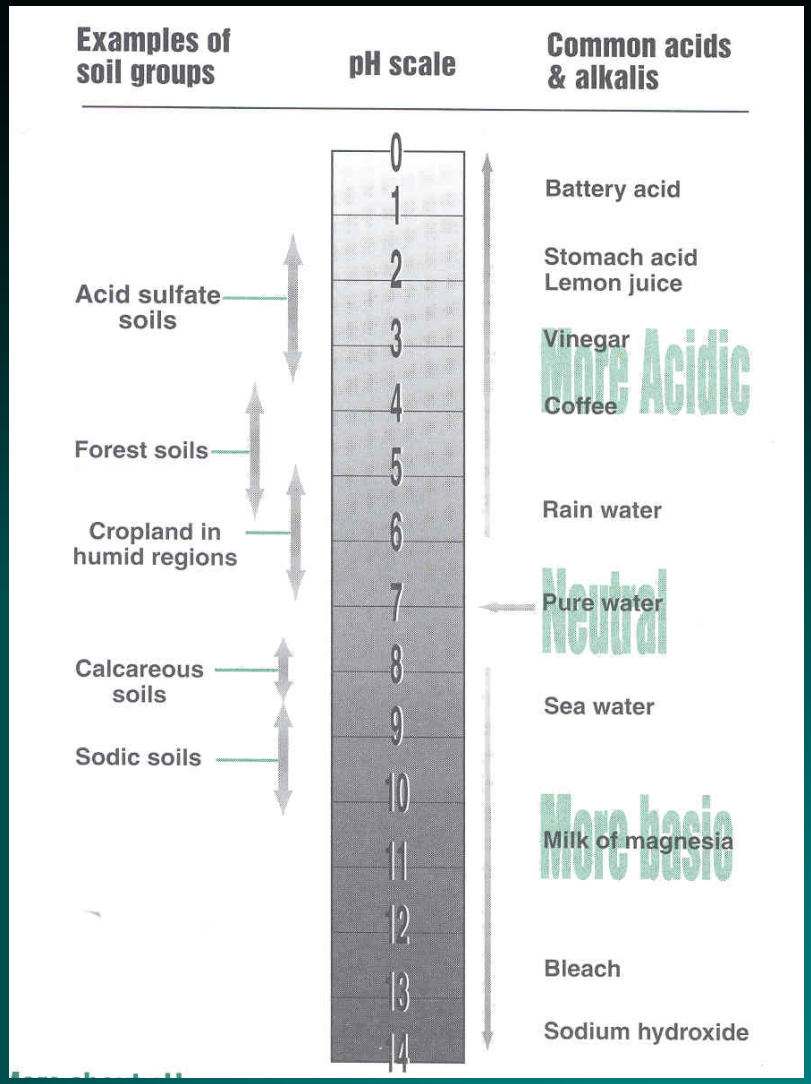
Properties Affecting Nutrient Availability

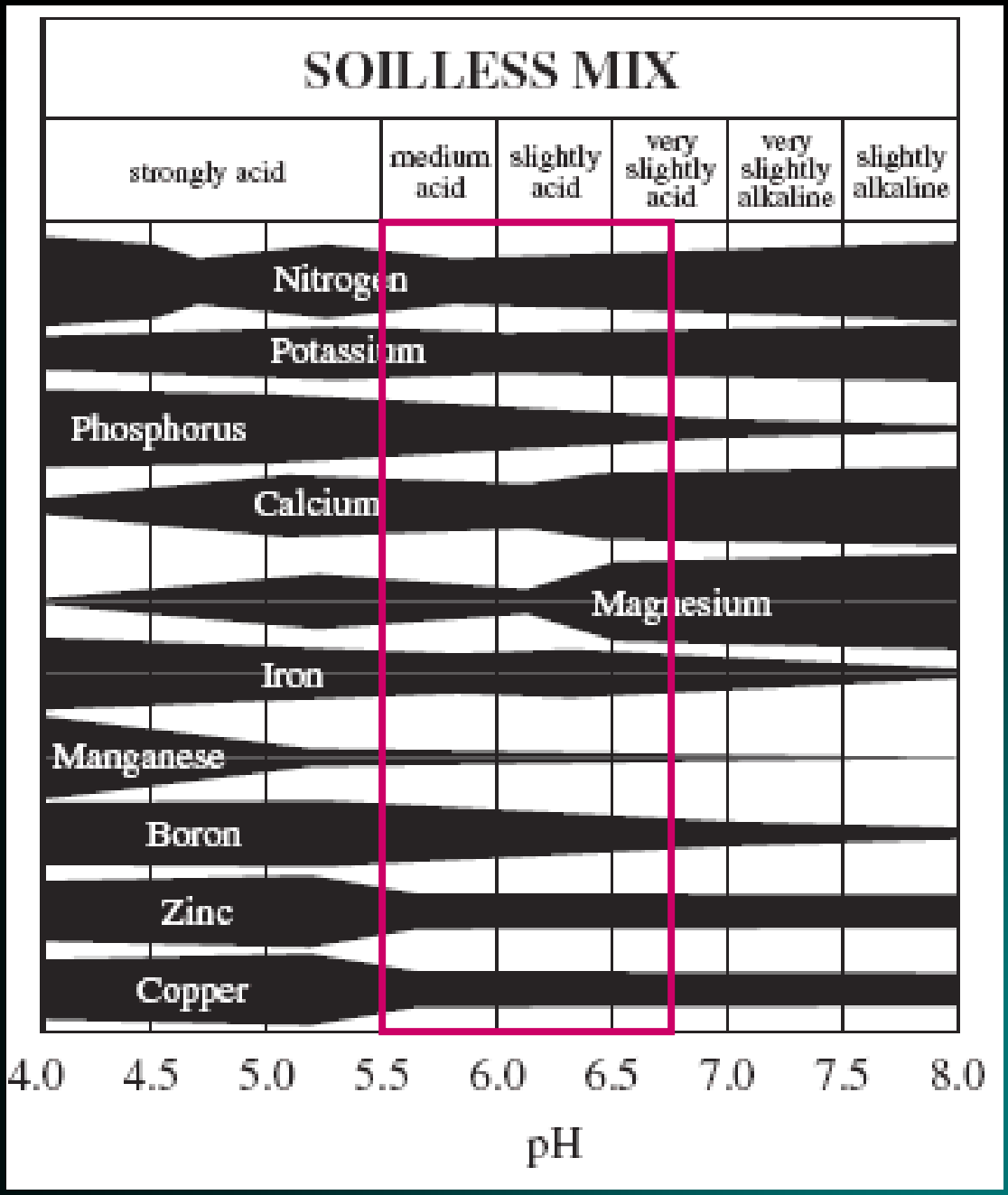
- Chemical Properties - pH

  p = potential or power

  H = hydrogen

  - pH and hydrogen ion concentration are inversely related.
  - As pH decreases, hydrogen ion concentration increases.




SOILLESS MIX
strongly acid
medium acid
slightly acid
very slightly acid
very slightly alkaline
slightly alkaline
Nitrogen
Potassium
Phosphorus
Calcium
Magnesium
Iron
Manganese
Boron
Zinc
Copper
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
pH

Irrigation Water Quality

It is essential
to have your water tested!

Irrigation Water Quality

Alkalinity

is a measure of a water's capacity
to neutralize acids

is not a measure of calcium and magnesium

…that’s Hardness

Irrigation Water Quality

Alkalinity

is a measure of a water's capacity to neutralize acids

Major chemicals contributing to alkalinity:

Bicarbonate ions (HCO_3^-)

- calcium bicarbonate ($Ca(HCO_3)_2$)
- sodium bicarbonate ($NaHCO_3$)
- magnesium bicarbonate ($Mg(HCO_3)_2$)

Carbonate ions (CO_3^{--})

- calcium carbonate ($CaCO_3$)

Irrigation Water Quality

Alkalinity

is a measure of a water's capacity
to neutralize acids

50.04 mg/L $CaCO_3$ = 1.0 meq/L $CaCO_3$

High Alkalinity

May cause a gradual increase in the growing media pH. It may be necessary to inject mineral acid (phosphoric or sulfuric) into the water or acidic media amendments, such as sulfur or “acid-forming” fertilizers, may be needed.

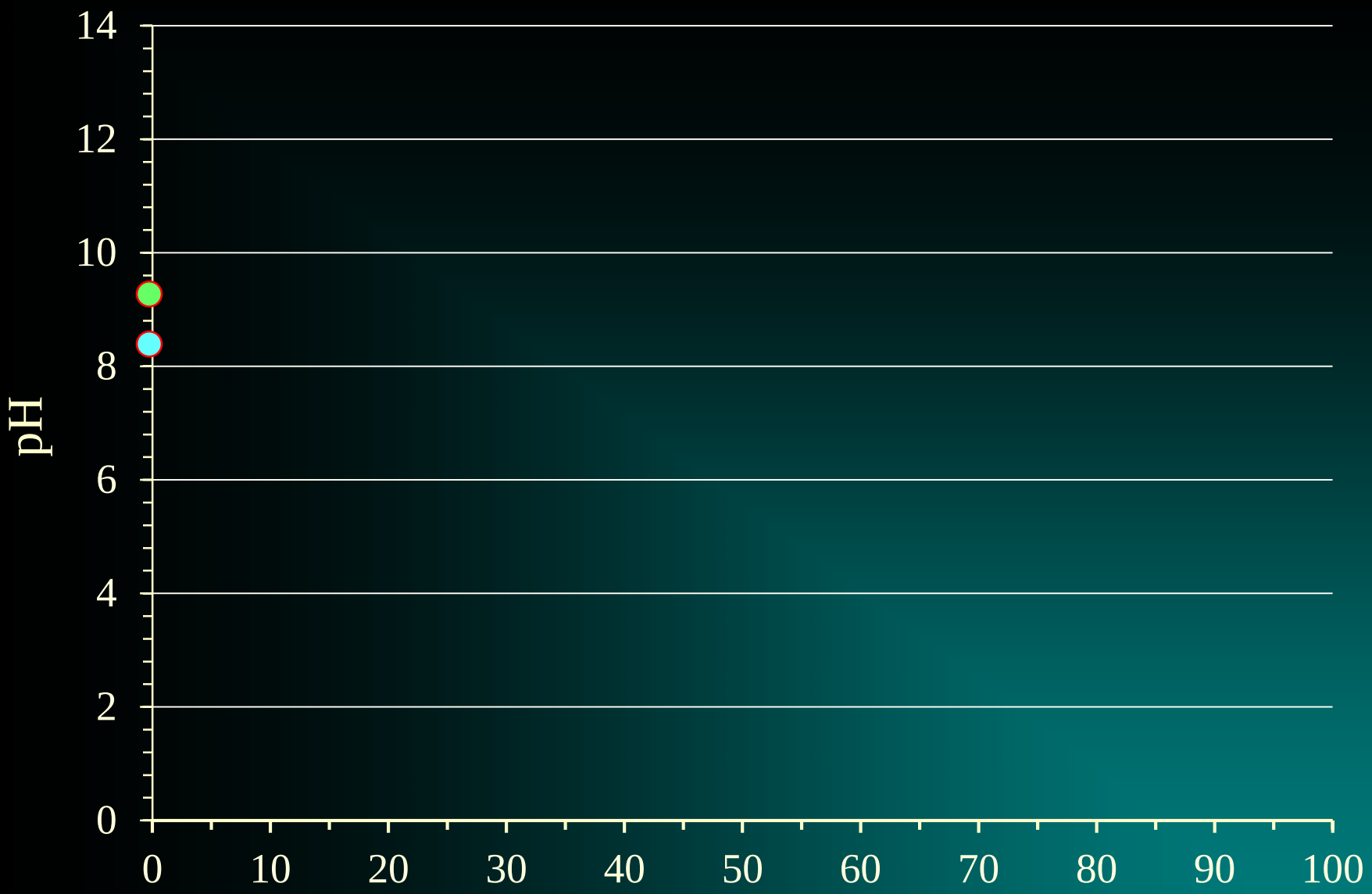
Low Alkalinity

May be deficient in calcium, magnesium or sulfate and additional supplements may be needed. A fertilizer program that alternates a potentially basic fertilizer with a low potential acidity fertilizer can help prevent pH crashes in the growing media.

Water Acidification Scenario

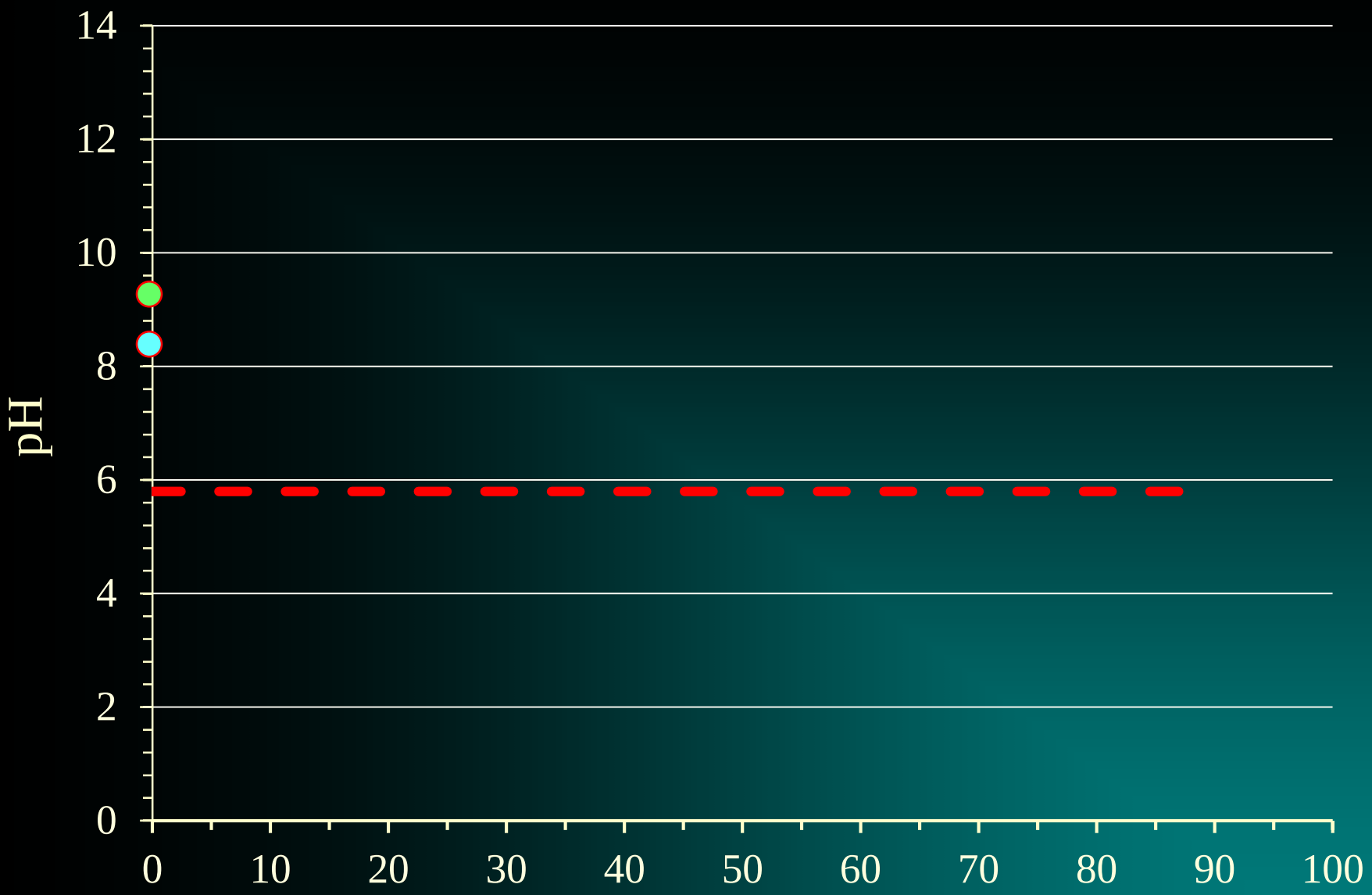
Grower A's Water		Grower B's Water	
pH	9.3	pH	8.3
Alkalinity	71 mg/l	Alkalinity	310 mg/l

http://www.ces.ncsu.edu/depts/hort/hil/hil-558.html



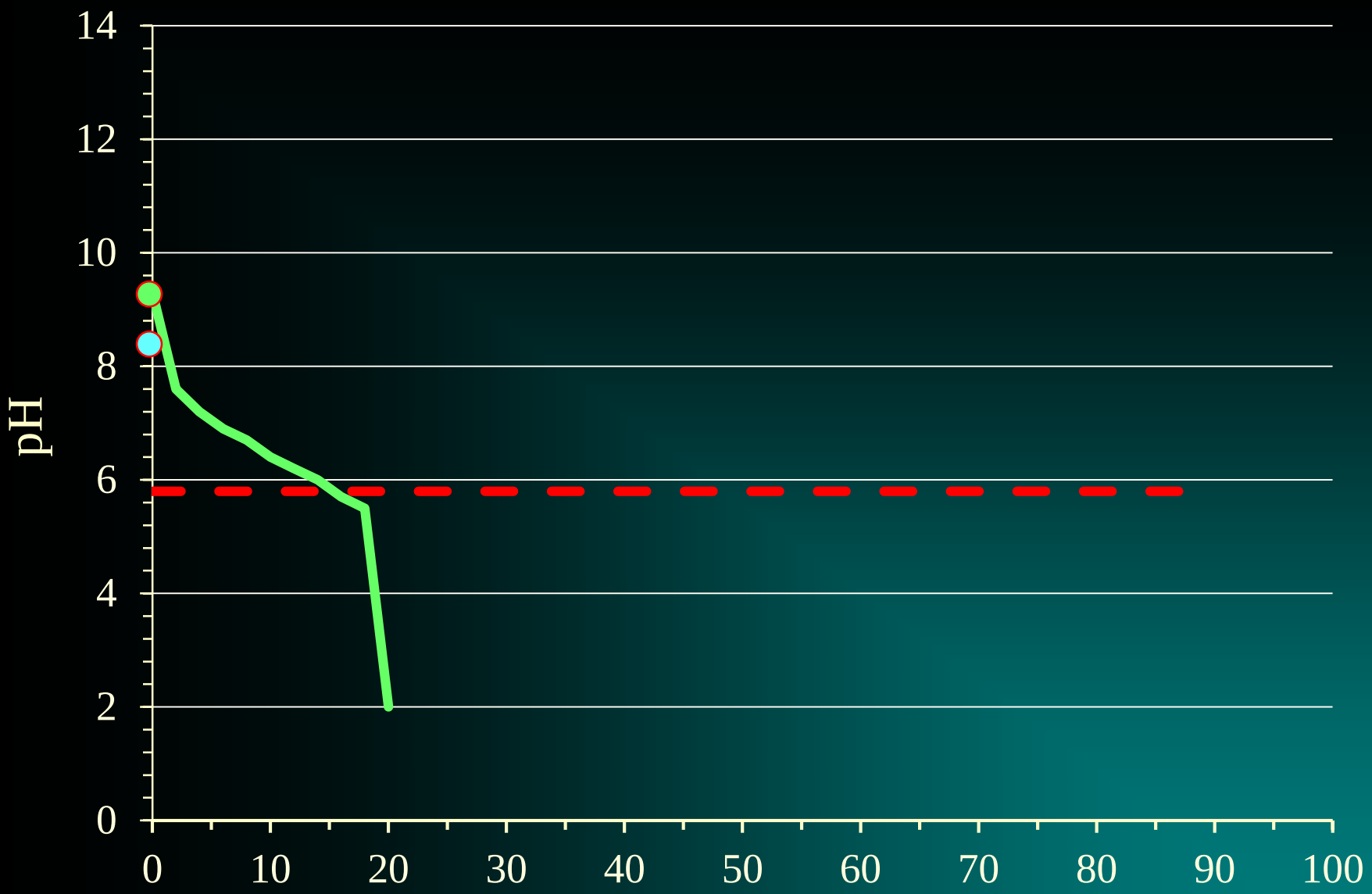
Fl oz of **35% Acid** / 1000 gallons of water

http://www.ces.ncsu.edu/depts/hort/hil/hil-558.html



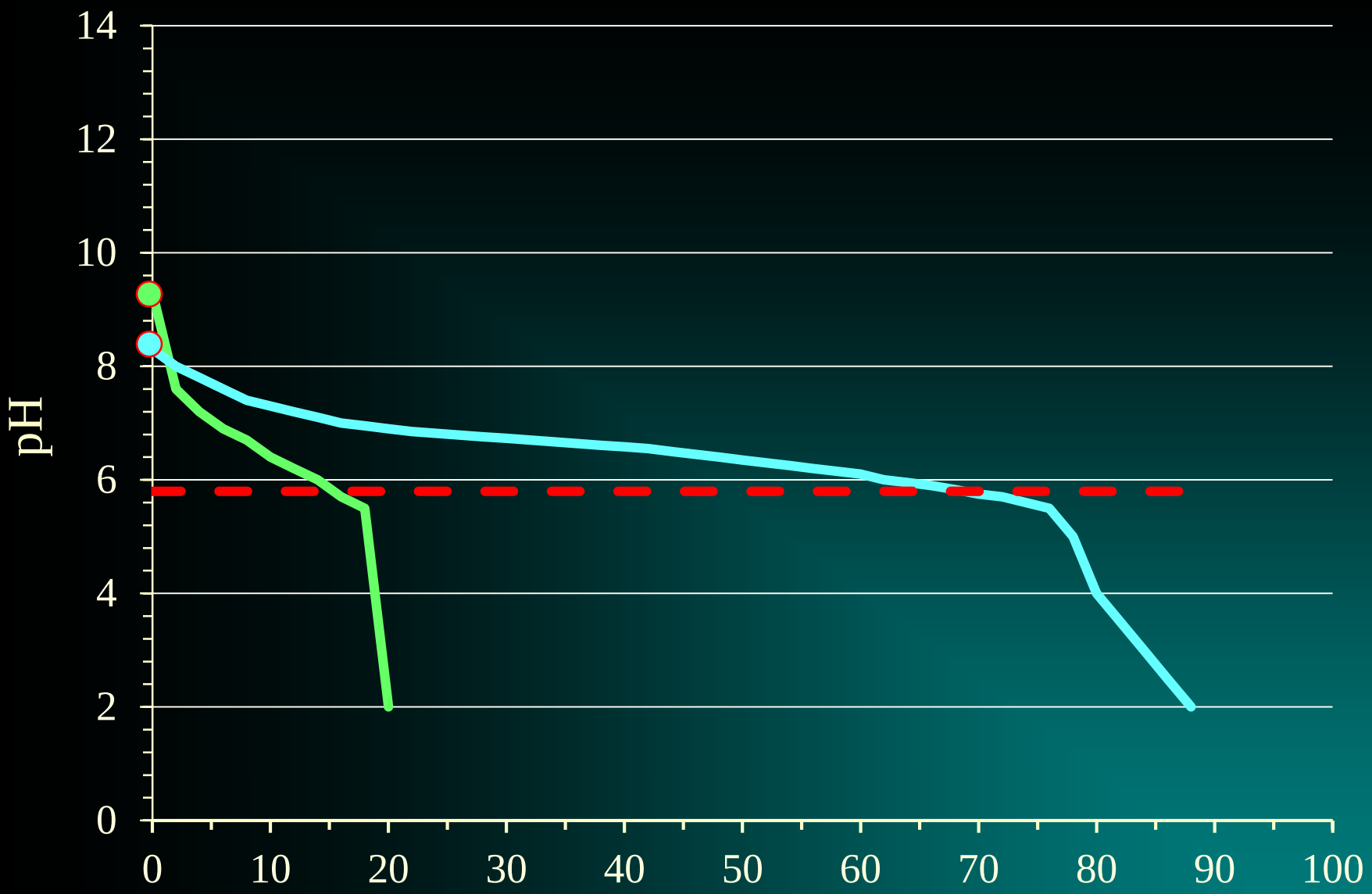
Fl oz of **35% Acid** / 1000 gallons of water

http://www.ces.ncsu.edu/depts/hort/hil/hil-558.html



Fl oz of **35% Acid** / 1000 gallons of water

http://www.ces.ncsu.edu/depts/hort/hil/hil-558.html



Fl oz of **35% Acid** / 1000 gallons of water

http://www.ces.ncsu.edu/depts/hort/hil/hil-558.html

Irrigation Water Quality

Alkalinity

is a measure of a water's capacity
to neutralize acids

50.04 mg/L $CaCO_3$ = 1.0 meq/L $CaCO_3$

35% Sulfuric Acid
11.0 fl oz/1000 gals
for each meq/L

Suggested alkalinity guidelines (mg $CaCO_3$/liter)[z].

Container size	Acceptable alkalinity	Concern level[y]
Plugs	60-100	<40, >120
Small pots	80-120	<40, >140
4-5" pots	100-140	<40, >160
>6" pots	120-180	<60, >200

[z] Alkalinity levels recommended through Scotts Testing Lab. Actual levels may vary depending on crop type and desired plant response.

[y] Low levels may result in media pH decrease, and high levels may result in media pH increase. These trends are highly dependent upon fertilization rate.

http://www.umass.edu/umext/floriculture/fact_sheets/greenhouse_management/adjalkal.html

Other concerns of irrigation water quality
Dissolved Micronutrients

Capacity factor	Upper limit for greenhouse use
Aluminum (Al)	0 to 5.0 ppm is normal range
Boron (B)	0.5 ppm
Copper (Cu)	0.2 ppm
Fluoride[H] (F^-)	1.0 ppm
Iron[I] (Fe)	0.2 to 4.0 ppm
Manganese (Mn)	1.0 ppm
Molybdenum	----
Zinc (Zn)	0.3 ppm

http://www.ces.ncsu.edu/depts/hort/hil//hil-557.html

Other concerns of irrigation water quality
Dissolved Micronutrients

Capacity factor	Upper limit for greenhouse use
Aluminum (Al)	0 to 5.0 ppm is normal range
Boron (B)	0.5 ppm
Copper (Cu)	0.2 ppm
Fluoride[H] (F^-)	1.0 ppm
Iron[I] (Fe)	0.2 to 4.0 ppm
Manganese (Mn)	1.0 ppm
Molybdenum	----
Zinc (Zn)	0.3 ppm

An important nutrient but too much is toxic

Toxicity shows as orange-brown necrosis along the margins of older leaves

http://www.ces.ncsu.edu/depts/hort/hil//hil-557.html

Other concerns of irrigation water quality
Dissolved Micronutrients

Capacity factor	Upper limit for greenhouse use
Aluminum (Al)	0 to 5.0 ppm is normal range
Boron (B)	0.5 ppm
Copper (Cu)	0.2 ppm
Fluoride[H] (F^-)	1.0 ppm
Iron[I] (Fe)	0.2 to 4.0 ppm
Manganese (Mn)	1.0 ppm
Molybdenum	----
Zinc (Zn)	0.3 ppm

Safe for most crops but toxic for many members of the lily family

http://www.ces.ncsu.edu/depts/hort/hil//hil-557.html

Other concerns of irrigation water quality
Dissolved Micronutrients

Capacity factor	Upper limit for greenhouse use
Aluminum (Al)	0 to 5.0 ppm is normal range
Boron (B)	0.5 ppm
Copper (Cu)	0.2 ppm
Fluoride[H] (F^-)	1.0 ppm
Iron[I] (Fe)	0.2 to 4.0 ppm
Manganese (Mn)	1.0 ppm
Molybdenum	----
Zinc (Zn)	0.3 ppm

Chamaedorea
Chlorophytum
Ctenanthe
Dracaena
Marantha
Spathiphyllum

Toxic levels of fluoride causes scorch of the tips of older leaves.

http://www.ces.ncsu.edu/depts/hort/hil//hil-557.html

Other concerns of irrigation water quality
Dissolved Micronutrients

Capacity factor	Upper limit for greenhouse use
Aluminum (Al)	0 to 5.0 ppm is normal range
Boron (B)	0.5 ppm
Copper (Cu)	0.2 ppm
Fluoride[H] (F^-)	1.0 ppm
Iron[I] (Fe)	0.2 to 4.0 ppm
Manganese (Mn)	1.0 ppm
Molybdenum	----
Zinc (Zn)	0.3 ppm

Although 4 ppm is maximum for plants, even as little as 0.3 ppm can lead to iron rust stains on foliage if water is used for overhead irrigation

http://www.ces.ncsu.edu/depts/hort/hil//hil-557.html

Other concerns of irrigation water quality
Dissolved Micronutrients

Check levels and assure that concentrations are below those indicated.

If the water source does contain high concentrations of these micronutrients, adjustments in the fertilization program should be made to prevent an overabundance of the elements.

Micronutrient toxicities are more probable when the pH of the substrate solution is low, facilitating higher availability for plant uptake.

Fertilizers and pH

Role of fertilizer source (N) and other nutrients on pH

Decrease pH

- ✓ Fertilizers with 50% or more of ammonium ($NH4^+$)

Increase pH

- ✓ Fertilizers wit 50% or more of nitrate ($NO3^-$)
- ✓ Cal-Mag fertilizers

Fertilizer (N-P2O5-K2O)	NH4 (%)	Potential Acidity (lb calcium carbonate to neutralize per 100 lb of fertilizer)	Potential Basicity (lb calcium carbonate equivalent)	Ca (%)
21-7-7 acid	90	85.0	-	0
24-9-9	50	41.1	-	0
20-2-20	69	40.0	-	0
20-18-18	73	36.5	-	0
24-7-15	58	30.6	-	0
20-18-20	69	30.5	-	0
20-20-20	69	29.2	-	0
20-9-20	42	25.5	-	0
20-20-20	69	23.7	-	0
16-17-17	44	22.0	-	0
17-0-17	20	-	3.8	4
15-5-15	28	-	6.8	5
13-2-13	11	-	10	6
14-0-14	8	-	11	6
15-0-15	13	-	16.0	11
15-0-15	13	-	21	11

Importance of Water Quality

Summary

- Water quality – Alkalinity
- Keep an eye on other elements in the water
- Fertilizer effect on pH chemistry

Evaluate this program
https://go.umd.edu/AGTEACH

or use the QR code to the right

Choose the presenter (Andrew Ristvey)
Choose the date
Choose Nutrient Management
Answer the questions
Submit

Thank you!