# Optimizing irrigation water quality in tunnels

*Neil Mattson*

nsm47@cornell.edu

# What makes good quality water?

| | |
|---|---|
| pH | 4.5-7.0 |
| **Alkalinity** | 40-100 ppm $CaCO_3$ , ideal<br>150-300 ppm $CaCO_3$ ,acidification<br><40 ppm $CaCO_3$ , poor pH buffering |
| **EC** | < 0.75 dS/m plugs/seedlings<br>< 1.5 dS/m general plants |
| Sodium | < 70 ppm (>70 ppm can damage roots and foliage) |
| Chloride | < 70 ppm (>70 ppm can damage roots and foliage) |
| Nitrogen | 10 ppm (>10 suggests agricultural runoff) |
| Phosphorus | 5 ppm |
| Potassium | <20 ppm (>20 ppm, decrease level in fertilizer) |



Water quality guidelines for greenhouse, Raudales et al., 2021

# Commercial testing labs for irrigation water

- Way Point Analytical
  https://www.waypointanalytical.com/Water
- JR Peters Laboratory
  http://www.jrpeters.com/
- Macro Micro Laboratory
  http://www.mmilabs.com/
- ICL Specialty Fertilizers Laboratory
  https://icl-sf.com/us-en/water-test/

# Water analysis from a commercial lab

**JR PETERS Laboratory**

"Superior horticultural testing since 1947"

6656 Grant Way, Allentown, PA 18106 • Phone: 610-395-1337 • FAX: 610-391-1337 • Toll Free: 1-866-522-5752
www.jrpeters.com

## SOLUTION ANALYSES

| | | | |
|---|---|---|---|
| ACCT # | 5100001 | | |
| NAME | Cornell University-Mattson | | |
| | Neil Mattson 134A Plant | DATE RECEIVED | 02/16/2015 |
| ADDRESS | Science Bldg | DATE COMPLETE | 02/17/2015 |
| CITY/STATE/ZIP | Ithaca, NY, 14853 | TURNAROUND | 1 |
| PHONE | 607-255-0621 | LAB I.D. | 15-227717 |
| FAX | e | SAMPLE I.D. | Genrich 1 |

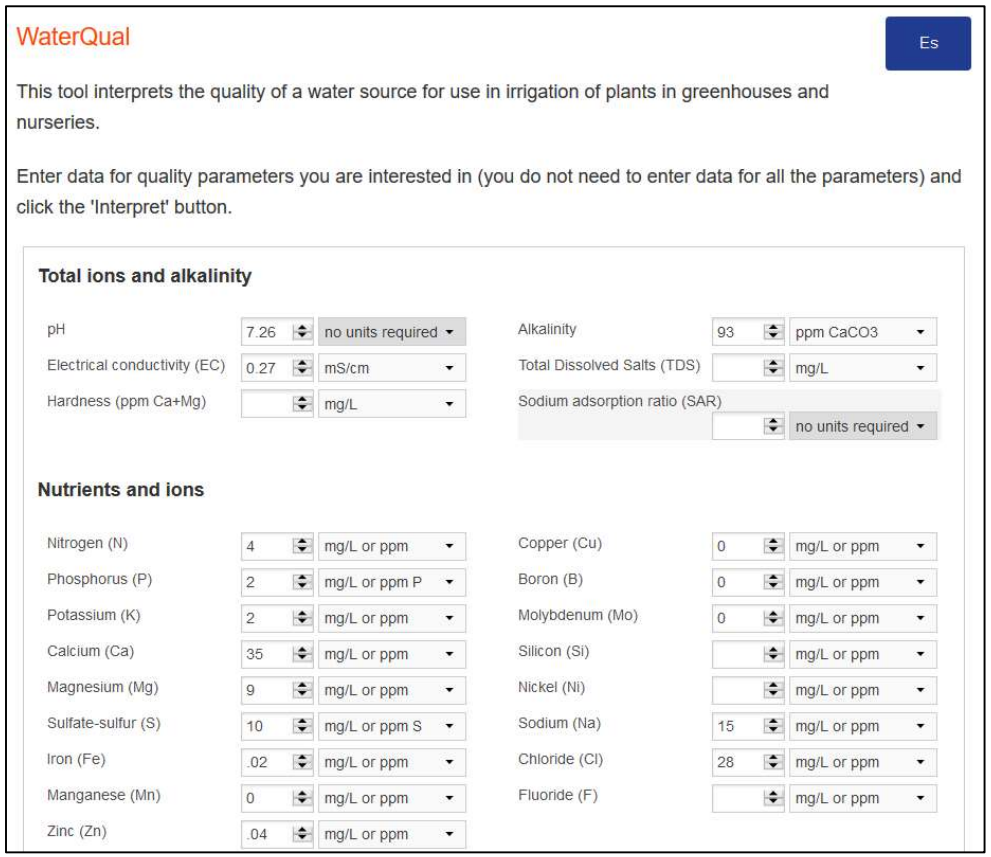
**SAMPLE QUESTIONAIRE RESPONSE**
**Sample Date = Feb 12, 2015, Sample Type = Water, Water Source = Municipal, Concerns/Problems = No Concerns, Fertilizer Specifics = , Desired Concentration = , Injector Information = , Comments =**

| TEST | RESULTS | NORMAL RANGE |
|---|---|---|
| Soluble Salts ms/cm EC | 0.27* | 0.30 - 1.00 |
| pH | 7.26 | 0.00 - 0.00 |
| ALK ppm CaC03 | 93.45 | 0.00 - 0.00 |
| Calcium ppm Ca | 35.2* | 40.00 - 75.00 |
| Magnesium ppm Mg | 9.35* | 30.00 - 50.00 |
| Sodium ppm Na | 14.65 | 0.00 - 50.00 |
| Chloride ppm Cl | 28.27 | 0.00 - 70.00 |
| Boron ppm B | 0 | 0.00 - 0.50 |
| Iron ppm Fe | 0.02 | 0.00 - 2.00 |
| Manganese ppm Mn | 0 | 0.00 - 1.50 |
| Sulfur ppm S | 10.19 | 10.00 - 80.00 |
| Copper ppm Cu | 0 | 0.00 - 0.20 |
| Zinc ppm Zn | 0.04 | 0.00 - 0.40 |
| Molybdenum ppm Mo | 0 | 0.00 - 0.20 |
| Aluminum ppm Al | 0.14 | 0.00 - 1.00 |
| Nitrate ppm NO3-N | 3.57 | 0.00 - 10.00 |
| Ammonium ppm NH4-N | 0.63 | 0.00 - 10.00 |

# WaterQual

Online tool to interpret greenhouse/nursery water quality

https://www.cleanwater3.org/wqi.asp



# Correcting poor quality water: high salts, Na or Cl

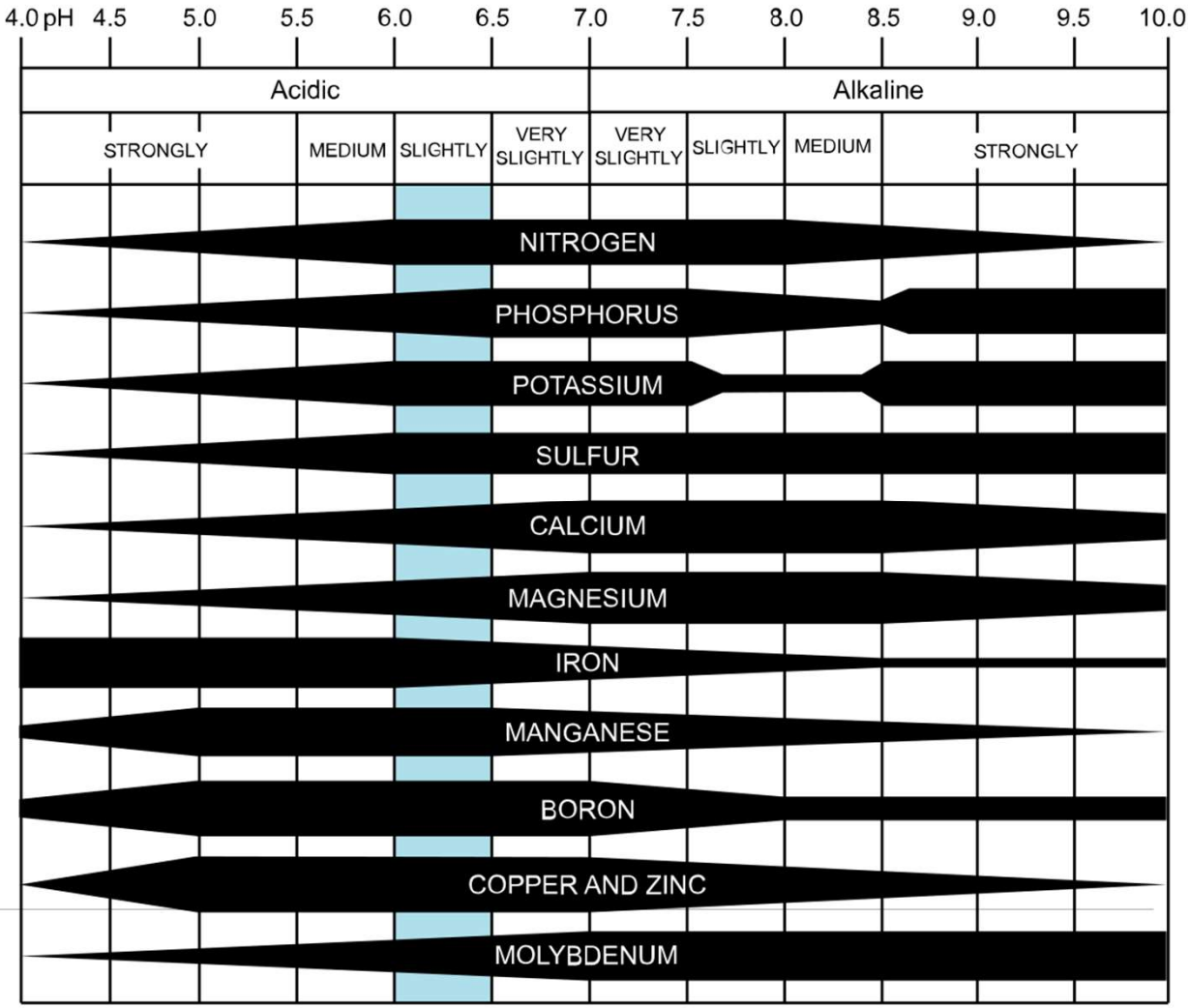
Change water source

- Municipal
- Well
- Pondwater
- Rainwater
- Reverse osmosis?

(Or some combination of blending the above with your current water source)

# Soil pH effects nutrient availability

- For most crops, soil pH of 6.0-6.5 is optimum
- For soilless media (potting mixes, raised beds) 5.5-6.0



# High pH causes micronutrient deficiency

- Iron/manganese deficiency are most common
- Symptoms: yellowing between the veins on upper (young) leaves
  - Can advance to overall yellow/white upper leaves


# Causes of high soil pH

- Soil naturally high in pH
- Excessive addition of compost
- Excessive liming of soil
- Use of nitrate based fertilizers
- High alkalinity of the irrigation water

# Correcting high soil pH

Conventional

- Elemental sulfur incorporation
- Aluminum sulfate and iron sulfate
- Use ammonium based nitrogen sources
  - Ex: Urea pre-plant and ammonium sulfate in fertigation
  - 1 pound urea equivalent to 3.9 pounds elemental sulfur
- Injection of acid to neutralize water alkalinity (sulfuric, phosphoric, nitric)

Organic

- Elemental sulfur incorporation
- Peat or pine bark mulch (requires large volume)
- Injection of organic certified acids (citric/acetic) to neutralize water alkalinity

# Elemental Sulfur Application

***Table 3.*** *Approximate amount of elemental sulfur needed to lower soil pH of a silt loam soil to a depth of 6 inches.*[1]

| Present Soil pH | Desired Soil pH | | | | |
|---|---|---|---|---|---|
| | 6.5 | 6.0 | 5.5 | 5.0 | 4.5 |
| | Pounds Elemental Sulfur per 100 Square Feet | | | | |
| 8.0 | 3.0 | 4.0 | 5.5 | 7.0 | 8.0 |
| 7.5 | 2.0 | 3.5 | 4.5 | 6.0 | 7.0 |
| 7.0 | 1.0 | 2.0 | 3.5 | 5.0 | 6.0 |
| 6.5 | — | 1.0 | 2.5 | 4.0 | 4.5 |
| 6.0 | — | — | 1.0 | 2.5 | 3.5 |

[1]For sandy soils, reduce amount by 1/3; for clay soils, increase amount by 1/2; if aluminum sulfate is used, multiply by 6.

If applying 4 pounds or more, split in half and apply 6 months apart
Requires active microbial community (warm, moist, aerated soil)
Takes up to 12 months for full pH effect

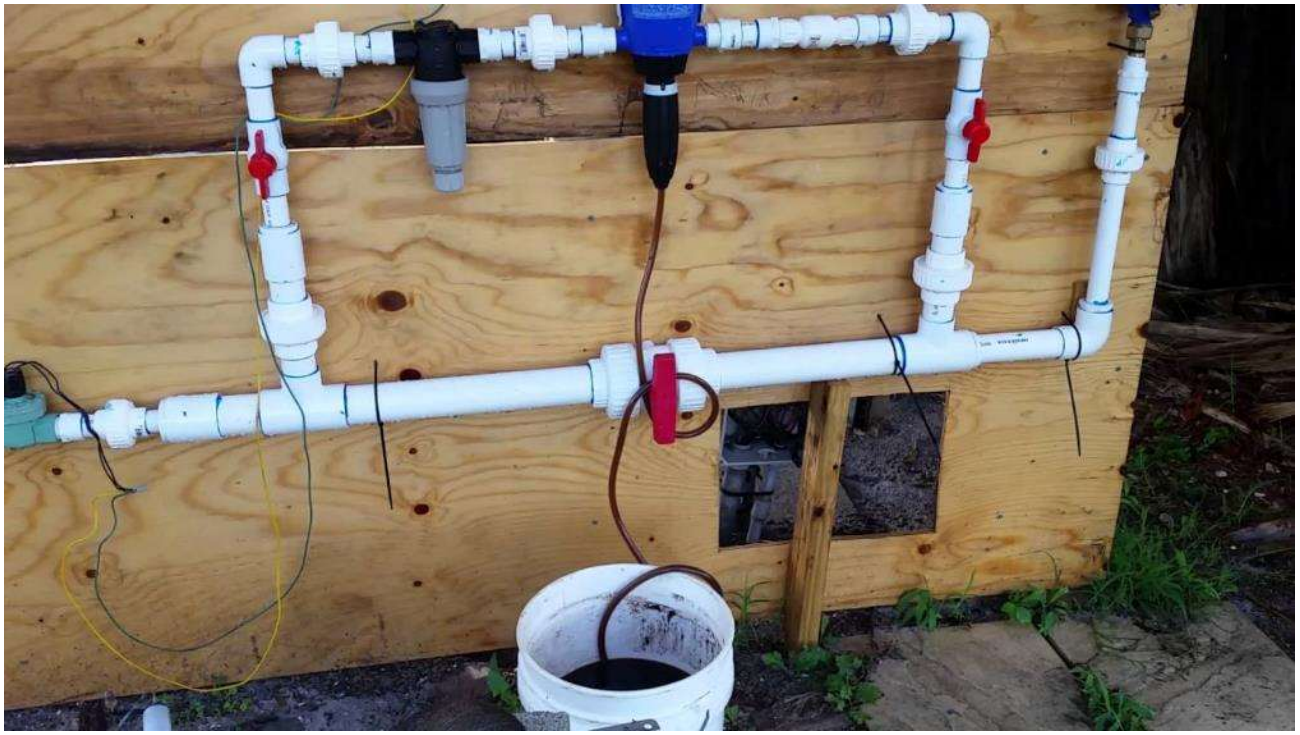


Source: Lowering Soil pH for Horticulture Crops (Purdue Extension HO-241-W)

# Correcting High Alkalinity

1) Change or blend the water source
   - Ex: rainwater (very low alkalinity) with moderate alkalinity well water
2) Use an acidic fertilizer
   - Fertilizers with ammonium-nitrogen
3) Inject acid into irrigation water

# Acid injection to neutralize water alkalinity



Acidification reduces the amount of carbonates and bicarbonates

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

# Which Acid to Use?

Conventional production:

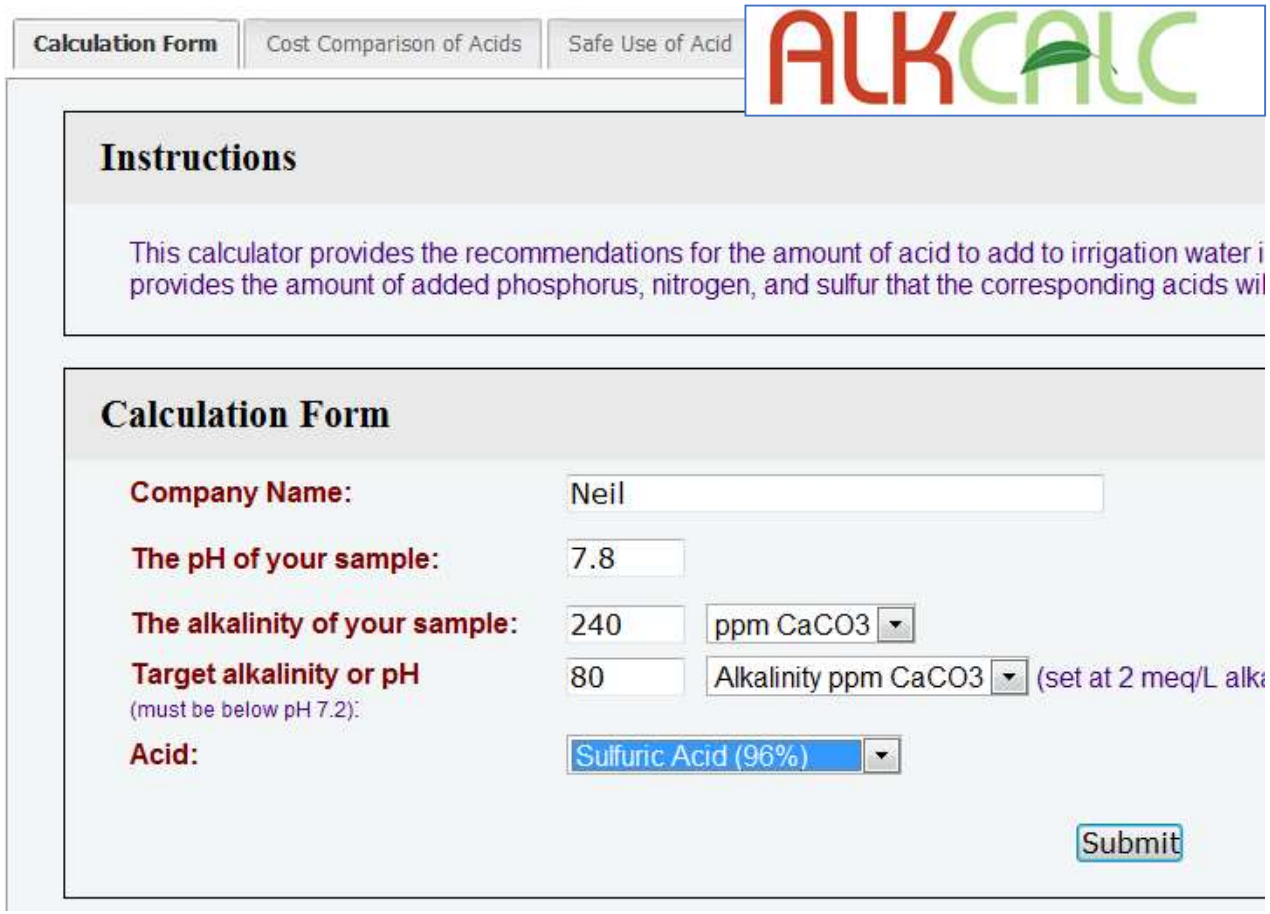
- Citric, nitric, phosphoric, and sulfuric

For organic

- Some Citric and acetic acids qualify for National Organic Program
- These are weaker acids than the conventional acids
  - More required, more expensive

# How much acid to use?

- Based on your water alkalinity and pH
- Add enough acid to bring pH down to 5.8 (alkalinity of 80 ppm $CaCO_3$)
  - Trial and error (add small amount of acid to concentrated stock tank, run water through injector and test hose-end)
- Conventional acids: use online calculator:
    - http://e-gro.org/alkcalc/
- Citric acid: **for every 50 ppm of alkalinity to neutralize**
  - 99.5% granular: 1 ounce per 100 gals (or 1 oz/gal. stock tank with 1:100 injector)
  - 50% liquid: 1.5 fluid ounces per 100 gals (or 1 oz./gal with 1:100 injector)






http://e-gro.org/alkcalc/

ALKCALC

| Amounts | Sulfuric Acid (96%) |
|---|---|
| For Small Volumes | |
| ml per liter | 0.089 |
| fl. oz. per gallon | 0.011 |
| ml per gallon | 0.338 |
| | |
| For a 1:100 Injector | |
| fl. oz. per gallon (conc.) | 1.14 |
| ml per gallon (conc) | 33.77 |
| | |
| For a 1:128 Injector | |
| fl. oz. per gallon (conc.) | 1.46 |
| ml per gallon (conc) | 43.22 |
| | |
| For a 1:200 Injector | |
| fl. oz. per gallon (conc.) | 2.28 |
| ml per gallon (conc) | 67.53 |



http://e-gro.org/alkcalc/

# Questions?

Neil Mattson
nsm47@cornell.edu