

Optimizing irrigation water quality in tunnels

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What makes good quality water?

рН	4.5-7.0	
	40-100 ppm CaCO ₃ , ideal	
Alkalinity	150-300 ppm CaCO $_3$, acidification	
	<40 ppm CaCO ₃ , poor pH buffering	
EC	< 0.75 dS/m plugs/seedlings	
	< 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
 <u>https://www.waypointanalytical.com/Water</u>
- JR Peters Laboratory <u>http://www.jrpeters.com/</u>
- Macro Micro Laboratory <u>http://www.mmilabs.com/</u>
- 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		
ACCT#	Cornell University-		
NAME	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 LD.	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
pН	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
Al annual lines	0.44	0.00 40.00

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WaterQual

Online tool to interpret greenhouse/nursery water quality

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



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WaterQual This tool interprets the quality of a water source for use in irrigation of plants in greenhouses and nurseries. Enter data for quality parameters you are interested in (you do not need to enter data for all the parameters) and click the 'Interpret' button. Total ions and alkalinity pH 7.26 🗢 no units required • Alkalinity ppm CaCO3 93 • Electrical conductivity (EC) 0.27 🖨 mS/cm Total Dissolved Salts (TDS) • ♣ mg/L • Hardness (ppm Ca+Mg) Sodium adsorption ratio (SAR) 🗢 mg/L • no units required • Nutrients and ions Nitrogen (N) Copper (Cu) 4 mg/L or ppm . 0 mg/L or ppm . Phosphorus (P) Boron (B) 2 🗣 mg/L or ppm P 🔹 0 mg/L or ppm . Potassium (K) 2 Image of the second • Molybdenum (Mo) ➡ mg/L or ppm . Calcium (Ca) Silicon (Si) 35 mg/L or ppm mg/L or ppm • . Magnesium (Mg) Nickel (Ni) 9 mg/L or ppm . mg/L or ppm .

Sodium (Na)

Chloride (CI)

Fluoride (F)

Sulfate-sulfur (S)

Manganese (Mn)

Iron (Fe)

Zinc (Zn)

10

02

.04

0

🗣 mg/L or ppm S 🔹

-

•

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mg/L or ppm

I mg/L or ppm

I mg/L or ppm

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mg/L or ppm

mg/L or ppm

mg/L or ppm

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Correcting poor quality water: high salts, Na or Cl

Change water source

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

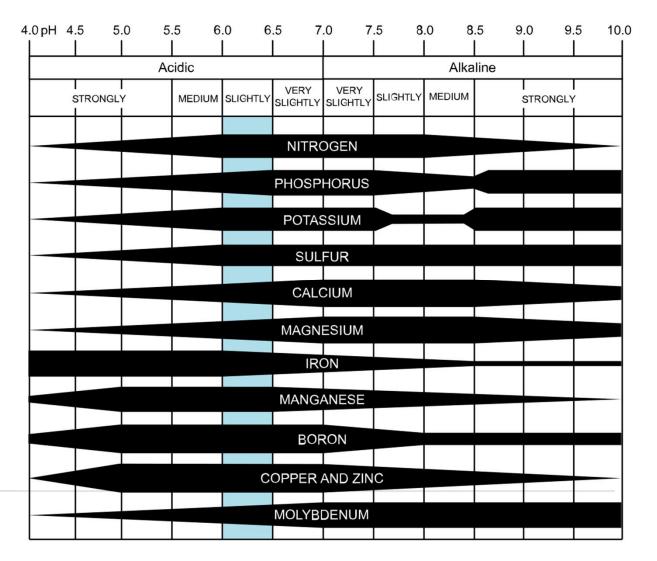
(Or some combination of blending the above with your current water source)





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

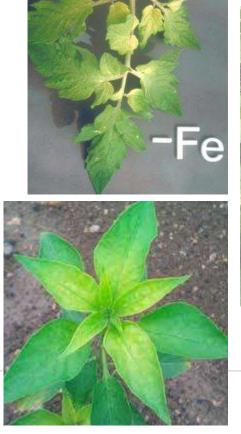




High pH causes micronutrient deficiency

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

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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	
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	Desired Soil pH				
Present 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

¹For 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

Cornell CALS College of Agriculture and Life Sciences 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

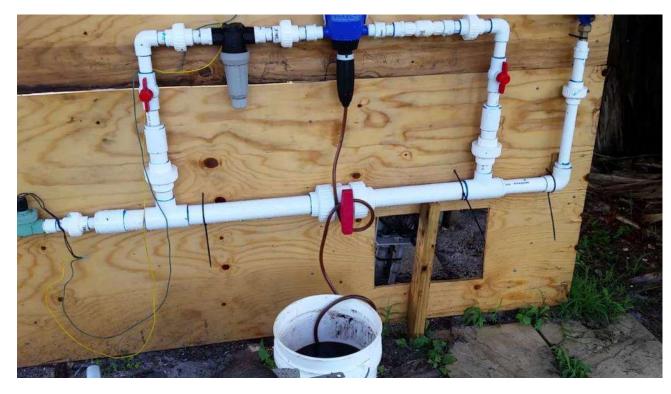




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Acid injection to neutralize water alkalinity



Acidification reduces the amount of carbonates and bicarbonates

H⁺ (from acid) + HCO₃⁻ (in water) \rightarrow CO₂ + H₂O

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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 CaCO₃)
 - 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:
 - <u>http://e-gro.org/alkcalc/</u>
- 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)



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Instructions		
		s for the amount of acid to add to irrigation wait itrogen, and sulfur that the corresponding acid
<u></u>		
Calculation Form		
Calculation Form Company Name:	Neil	
	Neil 7.8	
Company Name:		ppm CaCO3 💌
Company Name: The pH of your sample:	7.8	ppm CaCO3 Alkalinity ppm CaCO3 (set at 2 meq/l

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



	Sulfuric Acid
Amounts	<mark>(96%)</mark>
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/

