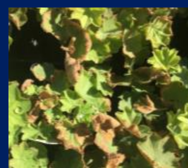
What's in Your Water?
2017 New Hampshire Water Survey

- Evaluate your water quality
- Compare with other growers in New Hampshire (anonymous)
- Final report with strategies to manage water quality, fertilizer, and irrigation
- Contact Ryan Dickson (ryan.dickson@unh.edu) or Amy Papineau (amy.papineau@unh.edu)



Leaf burn from high chloride in the irrigation water

University of New Hampshire Cooperative Extension

What is water quality?

- Dissolved salts, pH, alkalinity
- Microbial load

Can affect crop health, nutrition, and clog emitters

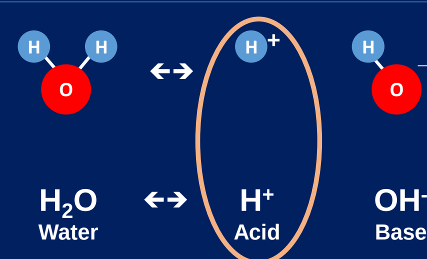
What is in your water?

What is in a basic water analysis?

- pH
- Alkalinity
- Soluble salts (EC)
- Specific nutrient concentrations

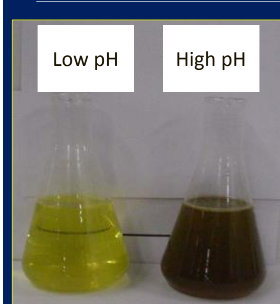
Nursery	Target ranges	
	Min	Max
pH	5.0	7.0
Alkalinity (ppm $CaCO_3$)	40	120
EC (mS/cm)	0.0	1.0
NO3-N (ppm)	0	10
P (ppm)	0	20
K (ppm)	0	150
Ca (ppm)	0	150
Mg (ppm)	0	75
SO4-S (ppm)	0	120
Fe (ppm)	0.00	2.0
B (ppm)	0.05	5.0
Na (ppm)	0	100
Cl (ppm)	0	70

What is pH?



Low pH values are ACID, high pH values are BASIC
What does pH affect?

WATER QUALITY: Solution pH



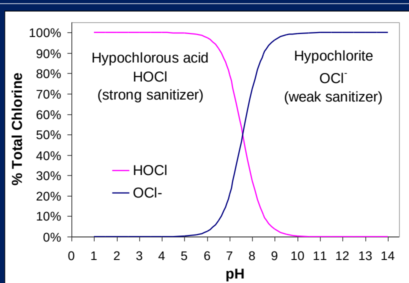
- Can be measured with a pH meter
  - <7 acid
  - 7 neutral
  - >7 basic
- Affects the solubility and activity of chemicals and fertilizer in solution
- Little effect on substrate-pH

pH affects solubility of iron

pH 4
Highly soluble
Fe^{3+}, Fe^{2+}

pH 7
Highly insoluble
$Fe(OH)_3$

Most agrichemicals are more effective at an acidic pH, for example chlorine



- Injecting acid can reduce chlorine cost, increase sanitizing effect, and reduce phytotoxicity risk.

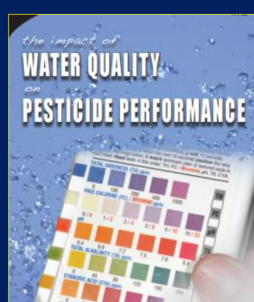
Control the pH of your spray tank for maximum effect of agrichemicals

Pesticide	Optimum pH range
Azadirachtin (Azatin)	3.0 - 7.0
Abamectin (Avid)	6.0 - 7.0
Acephate (Orthene)	5.5 - 6.5
Thiophanate methyl (Cleary's 3336)	6.0 - 7.0
Chlorothalonil (Spectro)	6.0 - 7.0
Fenhexamid (Decree)	5.5 - 6.5
Ancymidol (A-Rest)	5.5 - 6.5
Ethephon (Ethrel, Florel, Pistill)	Less than 5.0

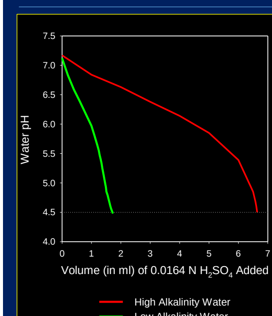
extension.umass.edu/floriculture/fact-sheets/effects-ph-pesticides-and-growth-regulators

Correct pH and hardness (Ca + Mg) of spray tank solutions

- Purdue University Extension
  - Impact of water quality on pesticide performance (https://www.extension.purdue.edu/extmedia/ppp/ppp-86.pdf)
  - Use acid or other water conditioners
  - Run a jar test to check complete dissolution



What is alkalinity?



- Dissolved bicarbonates in water
- Can NOT be measured with a pH meter
- Can have a large effect on substrate-pH
- Think of as dissolved limestone

Water Alkalinity is like dissolved limestone

Can raise pH in the substrate over time, resulting in micronutrient deficiencies

Alkalinity units

Milliequivalents Alkalinity (mEq/L)	ppm alkalinity ($CaCO_3$, or CCE)	ppm bicarbonate or HCO_3^-
1	50	61
2	100	122
3	150	183
4	200	244
5	250	305

Control alkalinity with mineral acid

- How much to add?
- Use online **AlkCalc** from University of New Hampshire

- Sulfuric (adds S)
- Phosphoric (adds P)
- Nitric (adds N)

- Bring water pH down to around 6 (~ 2 mEq/L or 100 ppm $CaCO_3$ for some alkaline water sources)

Match your fertilizer to your alkalinity

$N\text{-}P_2O_5\text{-}K_2O$	(NH_4-N + Urea-N)/ Total N	Potential reaction in lb/ton (A=acid, B=base)	Match to this ppm $CaCO_3$ of water alkalinity
21-7-7	100%	A 1560	300 ppm
20-10-20	40%	A 406	200 ppm
17-5-17	20%	B 0	100 ppm
15-0-15	13%	B 420	50 ppm

- High alkalinity can be balanced with high ammonium.
- BUT:
  - lush growth, ammonium toxicity in winter, and not effective when plants are small, substrate wet & cold.
  - If alkalinity is greater than 150 ppm $CaCO_3$, acid usually also needed.

20-10-20 Peat-Lite Special.

Total Nitrogen (N) 20%
7.84% Ammoniacal Nitrogen
12.16% Nitrate Nitrogen

Potential Acidity: 406 lb. Calcium Carbonate equivalent per ton.

7.84% ammonium / 20% total N = 39% of nitrogen in ammonium form

Micronutrient toxicity (iron and manganese)

Soluble salts (EC)

High soluble salts can potentially…

- Hard growth, stunting
- Burn roots
- Nutrient imbalance (Ca^{2+})

Root burn from salts building up in the substrate

Water with low soluble salts is easier to manage, allows for more fertilizer options

How do you manage water with high soluble salts?

Options include…

1. Increase leaching to prevent salt build-up
2. Increase fertilizer N rate
3. Prevent wilting
4. Search for a lower EC water
5. Reverse osmosis

Source water with a natural EC greater than 1.0 mS/cm is considered high

Nutrients can be added through the irrigation water

mS/cm or ppm:	EC	HCO_3	N	P	K	Ca	Mg	S
Fertilizer	2.0	0	229	46	220	146	50	63
Irrigation water	1.0	242	0	0.3	17	167	8	180
Expected drip solution	3.0	242	229	46.3	237	313	58	243

- May be able to reduce nutrients added by the fertilizer (Ca and Mg)
- Check for potential toxicities (Na and Cl, micros)

Examples of nursery water sources

Nursery	Example 1	Example 2	Target ranges	
			Min	Max
pH	7.6	7.1	5.0	7.0
Alkalinity (ppm $CaCO_3$)	35	242	40	120
EC (mS/cm)	0.11	1.0	0.0	1.0
NO3-N (ppm)	0.9	0.0	0	10
P (ppm)	<0.1	0.3	0	20
K (ppm)	2	17	0	150
Ca (ppm)	4.1	167	0	150
Mg (ppm)	2.3	8	0	75
SO4-S (ppm)	11	180	0	120
Fe (ppm)	<0.1	0.0	0.00	2.0
B (ppm)	0.001	0.1	0.05	5.0
Na (ppm)	15	28	0	100
Cl (ppm)	5.7	57	0	70

How often should you test your water?

When using a new water source

At least once per year before the season
- Contamination

Preferably twice per year (spring and fall)
- Drought, rainfall

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Where do you collect water samples?

Collect from source water
- Well
- Pond
- Municipal

Before injecting fertilizer or sanitizing chemicals

Again after injecting fertilizer

Examples of labs that test water quality

Cornell Department of Horticulture Analytical Lab

Fafard Analytical Services

MMI International Laboratory

North Carolina Department of Agriculture

Purdue University Toot Media Testing Lab

Scotts Testing Laboratory

Quality Analytical Laboratory

Examples of meters and kits for testing water quality in-house

Portable pH meter (~$125)

Alkalinity test kit (< $100)

Portable EC meter (~$125)

Good for routine testing of pH, EC, and alkalinity

Treating irrigation water for pathogens and algae

- Water can be a source for pathogens and algae
- High microbial load can clog emitters
- Variety of treatment options, but no "one type fits all"
- Free online publication of water treatment technologies and cost from University of Florida

Free online publication on water treatment technology
http://hort.ifas.ufl.edu/yprc/resources/water/pdfs/Water%20Quality%20Series%20from%20GMPro.pdf

How do you know if you need to treat your irrigation water for microorganisms?

- Noticing increase in diseases such as *Pythium* root rot
- Clogged emitters and slime (usually aerobic non-pathogenic bacteria)
- Work with a testing lab and test water before and after treatment
- Not uncommon to have some level of pathogens

10,000 c.f.u./mL aerobic bacteria is a threshold for increased disease risk and clogging emitters

The "dirtiest" water usually comes from surface or pond and recycled water sources

- Contains more debris, algae, and potential pathogens
- Aerate and move pond water to reduce algae and duckweed
- Municipal sources usually have less microbial load and debris

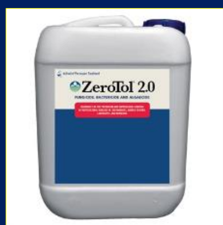
Pond or recycled water treatment starts with filtering out particles and debris

- Particles and debris hold pathogens and can also clog emitters
- Organic matter decreases efficacy of chemical treatment
- Most benefit from multi-stage filtration down to 5 to 50 microns
- Commercial labs can measure total suspended solids

Chlorine (calcium or sodium hypochlorite)

- Liquid or tablet dissolved to form hypohlorous or hypochlorite acid
- Inexpensive, commonly injected as "insurance"
- Filter out organic matter, keep pH below 6.8 (hypochlorous acid)
- Maintain 2ppm free chlorine, low residual activity

Peroxides and peroxyacetic acids

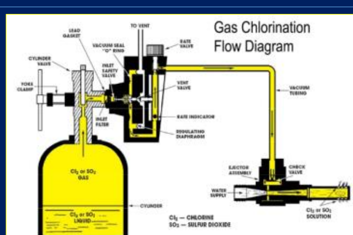


- Liquids are injected in-line, more expensive than chlorine
- Lower risk of phytotoxicity, safer for employees
- Easy to adjust injection rates depending on microbial load

Ultra-violet light (UV)

- UV-C (280 to 100nm) is effective, kills microbes and some viruses
- Filtration is necessary, UV light must "see" microbes
- Maintenance cost depends on pretreatment and electricity cost
- No residual activity

Gas chlorination (Cl_2 or ClO_2 gas)



- Gas injected in-line, forms hypochlorous or hypochlorite acid
- Effective at 0.25ppm total chlorine, provides residual activity
- Gas is toxic, requires handling and safety training

Copper ionization

- Injects free copper (Cu^{2+}) as a sanitizing agent
- Less affected by organic matter, good for surface water
- Recent technology is more efficient, cost-effective
- Extra copper may lower solubility of some chelated micronutrients

Ozone (O_3) gas injection

- Forms reactive peroxygens/oxygen radicals, good residual activity
- High initial cost (>$10,000), low operating cost (electricity)
- Gas is toxic, special safety and handling training is required

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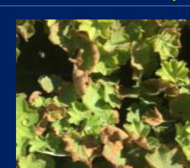

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