Water/Media/Nutrition

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ProGreen Expo 2019

Water

- Sources
  - Deep Well
  - Shallow Well
  - Ditch Water
  - City Water
- Water Analysis
- Water Quality
- Chemistry

Media

- Mixing your own vs. Pre-formulated Mixes
- Properties
- Media Components
- Media Chemistry
  - pH
  - Soluble Salts
  - Nutrients
- Selecting your mix
- Media Analysis

Nutrition

- Macronutrients
- Micronutrients
- Fertilizers
- Pre-formulated vs. Mixing your own
- Acidification
- Plant Analysis

Water Sources

- Deep Well - >50'
  - Typically good quality
  - Typically consistent quality
  - Test yearly

Shallow Well

- Up to 50’
- May be surface water
- Typically inconsistent water quality
- Many times poor water quality
- Test monthly

Ditch Water

- Water quality varies by season
- Typically good quality in the spring due to runoff
- Quality worsens as the summer progresses
- Test before use in spring and later in summer
- Who are your water neighbors? Beware runoff- theirs and yours.

City Water

- Typically excellent water quality
- Very consistent water quality
- Test yearly

Water Analysis

- Choose a dependable lab that provides interpretation of results
- Requires minimum of 1 pint water
- Use clean plastic container as glass may leach boron into the sample
- Fill to top of container with no air between water & container
- Run water before filling container

Water Quality

- Quality is determined by test results
- pH, soluble salts and mineral analysis will determine quality

pH

- Measures hydrogen ion concentration
- Reported in units from 0.0 to 14.0
- Typical water pH is from 6.0-8.0
- <7.0 is acidic >7.0 is basic 7.0 =neutral
- pH readings can increase over time due to lost dissolved carbon dioxide when exposed to air

Alkalinity

- Measure of the bicarbonate & carbonate levels in the water
- Establishes the buffering capacity of the water
- This measures how resistant the water will be to changes in pH
- The higher the bicarbonate levels the more resistant the water will be to change in pH

Salinity

- Total salts, EC, electrical conductivity
- Measures in mmhos/cm (millimhos/cm) or dS/m (decisiemens per meter)
- These units are equal units of measure
- In irrigation water the lower the salinity to start the better the water quality.
- High salinity can be reduced with reverse osmosis, deionization, or blending of waters.

Calcium, Magnesium & Sodium

- Present is some quantity in most waters
- The relative concentration of these elements greatly determines the water quality
- Labs calculate the SAR using the reported quantities of these elements
- Measured in ppm (mg/l) or Meq/l

SAR

- Sodium Adsorption Ratio
- Calculation
- SAR=Meq/l Na divided by the square root of the Meq/l of Ca & Mg divided by 2
- Expresses the amount of sodium present in the water compared to the Ca & Mg levels
- The lower the level the better
- Gypsum can be used to neutralize high sodium levels, but also increases EC

Chloride

- Recommend as low as chloride level as possible
- Present as a component or contaminant in many fertilizers

Sulfate

- Essential nutrient
- Typically present in some amount in water sources.
- Sulfur occurs as sulfate ion in water source

Micronutrients

- Zinc, iron, copper, manganese & boron
- Present in small amounts in waters
- Not typically a problem in waters
- Boron may be a problem if present in high quantities (>1.0 ppm)

Macronutrients

- Nitrates, ammonium, potassium & phosphate
- Typically the nutrients most needed by plant material
- Usually present in small quantities in water sources
- Added to water in fertilizer regimens

Fluoride & Lithium

- Can cause problems if present in high quantities
- Lithium->2.5 ppm
- Fluoride-> 1.0 ppm
- Certain plant materials may be sensitive

Grower Testing

- pH- can be measured on site with pH pen/meter
- EC-can be measured on site with solubridge
- Meters must be calibrated often
- Other testing should be performed at qualified labs

LABORATORY TESTING SERVICES

WATER ANALYSIS REPORT

REPORT TO: LAB NO: 5307

BILL TO: DATE RCVD: 1/25/99

REPORTED: 2/2/99

SAMPLE ID: GREENHOUSE WATER 1/25/99 PO NO.: PRE-PAID

PARAMETER	MG/L	SUGGESTED LEVELS - IRRIGATION WATER
SULFATE-S	14.2	24-240
SULFATE	42.6	
NO3-NITROGEN	3.08	5+
NITRATE	13.64	
CHLORIDE	5.1	0-140
TOTAL ALKALINITY as CaCO3	145.9	0-100
CARBONATE	0.0	
BICARBONATE	178.0	
PHOSPHATE	0.06	.2-15
CALCIUM	41.2	40-120
MAGNESIUM	11.6	6-24
HARDNESS as CaCO3	103.0	
SODIUM	16.8	0-50
POTASSIUM	8.8	.5-10
IRON	0.009	2-5
COPPER	0.002	0-.2
AMMONIA-N	<.10	
BORON	0.51	.2-.8
pH (UNITS)	7.66	
SALINITY (UMHOS/CM)	329.0	0-1500
SAR (UNITS)	0.60	0-4
SALINITY HAZARD	MEDIUM	
SODIUM HAZARD	LOW	

Mailing Address

Media - Function

- Provides physical support for plant
- Provides area for root zone of plant
- Provides a water reservoir
- Provides nutrition source

Media Properties

- Physical Properties
- Porosity- Total pore space of a media-Volume minus solids
- Pore space can hold air & water
- You need a mix of these pore spaces
- Sand has larger pore spaces, greater drainage & holds more air-less water
- Clay soils have smaller pore spaces, less drainage & hold more water & less air

Chemical Properties

- Cation Exchange Capacity
  - CEC
  - Essentially the ability of a media to hold nutrients added as fertilizers
  - Calculated in lab
  - Level of 6-15 Meq/100 cc is desirable
  - Perlite is about 2 while sphagnum peat is about 100
  - Mixing components gives the desired level

pH

- Measure of hydrogen ion concentration
- Soilless media- 5.4-6.0
- Mineral soils- 6.2-6.8
- Determines level of nutrient uptake by plant
- All media components & fertilizers add to determine pH

Soil Additives Affecting pH

- Limestone & dolomitic lime raise pH
- Gypsum is pH neutral
- Acids decrease pH
- Sulfates decrease pH
- Peat moss & coir decrease pH

Soil Conductivity

- All fertilizers & media components add to EC
- Contaminants, fungicide and insecticide drenches increase EC
- The “relative” EC increases as media moisture decreases
- Roots may be damaged by mid level EC’s when the media dries out completely while the same EC level is no problem when media is moist
- Never let a media dry out completely!

Chemical Analysis

- Result of total media components and any fertilization added to media
- Will directly reflect the chemical analysis of the water used to irrigate the media
- Need to determine analysis with media analysis in qualified lab

Soil Components

- Sand
  - Good support
  - Poor water & nutrient holding capacity
  - Adds weight to containers
- Field Soil
  - Good nutrient & water holding capacity
  - Beware contaminants-Know your source
  - Need to sterilize before use

- Peat Moss
  - Sphagnum peat is preferred
  - pH typically 3.0-4.0
  - Water holding and nutrient holding capacity is excellent
  - Will need addition of a pre-plant to increase pH

- Coir
  - Coconut fiber
  - Typically ground
  - Finer than peat moss
  - Aeration less than peat moss
  - Water holding capacity is good
  - Be cautious of high EC/sodium levels

- Manures
  - – Not your best idea
  - – Inconsistent
  - – Must be fully composted
  - – High EC's are common
  - – Must be sterilized
  - – Watch for high ammonia levels

- Barks
  - Should be composted
  - Softwood pH 3.0-4.0
  - Hardwood pH 6.5-7.5
  - Some hardwood species phytotoxic
  - Know your source

- Sawdust
  - Never a good idea in greenhouse production
  - C:N ratio 1000
  - Requires complete composting
  - If not composted totally will use up all nitrogen in decomposition and nitrogen deficiencies will result

- Vermiculite
  - Mica like silicate ore
  - Chemically inert
  - Good water holding capacity
  - Contains some K, Ca, Mg
- Perlite
  - Expanded volcanic silicate
  - White
  - Chemically inert
  - Light weight, adds aeration
  - May contain high Fluoride levels

- Calcine Clay
  - Heated montmorrillonite clay
  - High CEC
  - Variable pH   5-9
  - Good aeration

- Polystyrene Foam
  - Very light
  - No water holding capacity
  - No CEC
  - Too light -Floats
- Rockwool
  - Molten volcanic rock that is expanded
  - Promotes good root growth
  - High water availability
  - Slightly alkaline
  - Used in hydroponics

Pre-mixed vs. Mix your own

- Pre-mixed more costly, but take less labor
- Large greenhouses can have media companied special mix to their needs
- Soil mixing areas can take a lot of space and require specialized equipment for large quantities.
- High level of control when you mix your own.
- Mixing your own takes skill and skilled employees in order to achieve a good media.
- Must determine economic feasibility and level of quality control if you decide to mix your own.

Media Analysis

- Send to qualified lab that provides interpretation
- Need about 1 cup by volume of media
- Can typically test pH & possible EC on site
- Physical and chemical tests need to be done by lab
- Test slightly moist media-not too dry or too wet
- Send in plastic baggie to lab or use lab provided sample containers

Nutrition

- Macronutrients
  - Nutrients used in larger quantities by plants
  - N, P, K, Ca, Mg, S
  - Mobile in plants except for Ca
- Micronutrients
  - Nutrients used in smaller quantities by plants
  - Zn, Fe, Cu, Mn, B, Mo, Cl, Ni
  - Immobile in plants

LABORATORY ANALYSIS REPORT

REPORT TO:

BILL TO:

LAB NO: 6970.01

DATE RCVD: 8/24/99

REPORTED: 8/30/99

PO NO.: 8569

ANALYSIS REQUESTED:

1 SOIL SAMPLE FOR COMPLETE SPURWAY NUTRIENT ANALYSIS

ANALYSIS REPORT:

	#3 CORTEZ SOIL RW49 R3H5N (PPM IN EXTRACT)		(MMOLES)	(UMOLES)	GENERAL ACCEPTABLE RANGE (PPM)
SODIUM	19.5	A	0.85		5-40
CALCIUM	355.9	H	8.90		40-200
MAGNESIUM	52.9	A	2.18		20-100
POTASSIUM	64.9	A	1.66		50-175
NITRATE-NITROGEN	25.97	L			70-180
NITRATE	115.03	L	1.85		310-797
NITRITE-NITROGEN	<1				
SULFATE-SULFUR	18.40				
SULFATE	55.20		0.56		
PHOSPHORUS	9.80	A	0.31		5-25
IRON	0.892	A		15.957	0.3-3.0
COPPER	0.014	A		0.220	0.01-0.50
MANGANESE	0.183	A		3.332	0.01-0.50
ZINC	0.156	L		2.386	0.3-3.0
AMMONIA	1.70	A	0.100		1-20
BORON	0.17	A			0.1-2
pH (SAT PASTE)	6.38	A			5.5-6.5
SALTS (MMHOS/CM)	0.70	A			0.5-3.5

L=LOW
A=ACCEPTABLE
H=HIGH

Nitrogen

- Used in greatest amount by plant
- Organic nitrogen
  - Urea
  - Cannot be detected by soil analysis
  - Not recommended for use in ornamentals
- Ammoniacal
  - Ammonium nitrate
  - Ammonium Sulfate
  - Ammonium phosphate
  - Used less by plant than nitrate type nitrogen
  - Be cautious of ammonium toxicity

- Nitrate Nitrogen
  - Calcium Nitrate
  - Potassium nitrate
  - Ammonium nitrate
  - Used in largest quantity by plants therefore added in larger quantities in fertilizer program
  - Watch compatibilities of calcium nitrate with other fertilizer sources

Nitrogen Growth Responses

- Nitrate
  - Short internodes
  - Vigorous root growth
  - Toned (hard) plant
  - Small leaves
- Ammonia
  - Large leaves
  - Soft growth
  - Darker green foliage with soil temps above 60 F
  - Chlorotic growing points with soil temps below 60 F

Phosphorus

- Pre-Plant
  - Super Phosphate
- Constant Liquid Feed Program
  - Mono-ammonium phosphate
  - Di-ammonium phosphate
- Acidification
  - Used to increase P level and decrease pH
  - Can lead to high media P levels

Potassium

- CLF
  - Potassium nitrate
    - Nitrogen source as well
  - Potassium chloride
    - Cheap
    - Increase chloride & EC levels
  - Potassium sulfate
    - Can also help to reduce pH slightly

Calcium

- Pre-plants
  - Limestone
    - Calcium carbonate
    - Increase pH
  - Dolomitic Limestone
    - Calcium carbonate & Magnesium carbonate
    - Increases pH
  - Gypsum
    - Calcium Sulfate
    - pH neutral
    - Can cause pH slide if used in excessive quantities over long periods of time

Calcium

- CLF
  - Calcium nitrate
  - Not compatible with phosphoric acid or sulfuric acid
- Spray
  - Calcium chloride
  - Foliar spray
  - Be careful of rates
- Chelated Calcium
  - Expensive
  - Increase calcium levels

Calcium Uptake

- Active water uptake is required for calcium uptake into the plant.
- Periods of overcast and then bright sun may induce calcium deficiencies in the plant, but the media may not actually be calcium deficient.

Magnesium

- Pre-plant
  - Dolomitic Limestone
  - Calcium Carbonate & Magnesium Carbonate
- CLF
  - Magnesium Nitrate
  - Magnesium Sulfate
    - Epsom Salts
    - Not compatible with Calcium nitrate

Sulfur

- Many times sulfur is adequate in water source
- Sulfate fertilizers increase sulfur levels
  - Magnesium sulfate
  - Sulfuric acid
- Deficiency is marked by general, overall yellowing of plant
- Deficiency is not that common

Micro-Nutrients

- Added as sulfates
  - Cheap
  - Easily tied up in media and unavailable to plant
- Added as chelates
  - More expensive
  - Not tied up in media

Acidification

- Acids added to fertilizer program
- Nitric
  - Adds nitrogen
  - Mixes with all other fertilizers
- Phosphoric
  - Watch P rates in media
  - Does not mix with calcium nitrate
- Sulfuric
  - Do not mix with calcium nitrate
  - Do not use battery acid

Plant Analysis

- Essential to any greenhouse testing program
- Test soil, water and plant tissue for complete picture
- Test most recently matured fully expanded leaves
- Send to lab in paper bag
- For some crops, testing levels are outlined- contact your lab for details

LABORATORY TISSUE ANALYSIS REPORT

REPORT TO:

BILL TO:

DESCRIPTION: 2 TISSUE SAMPLES FOR STD NUTRIENTS
TISSUE TYPE: POINSETTIA

DATE RCVD: 8/24/99
REPORTED: 8/31/99
LAB NO.: 6969
PO#: 8569

SAMPLE ID	TOTAL N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Na (PPM)
#1 CORTEZ RW49 R3H5N	4.61 A	0.39 A	1.41 L	1.00 A	0.22 L	1015
#2 MAREN RW 48 R3H1NB5	4.32 A	0.41 A	1.60 A	0.71 A	0.18 L	623

SAMPLE ID	Fe (PPM)	Cu (PPM)	B (PPM)	Mn (PPM)	Zn (PPM)	S (%)
#1 CORTEZ RW49 R3H5N	112.2 A	4.5 A	19 L	26.2 L	19.9 L	0.225 L
#2 MAREN RW 48 R3H1NB5	49.9 L	4.5 A	33 A	23.9 L	21.3 L	0.180 L

NUTRIENT CLASSIFICATION - POINSETTIA TISSUE

	L=LOW	A=ACCEPTABLE	H=HIGH
TOTAL NITROGEN, %	< 4.0	4.0 - 6.0 >	6.0
PHOSPHORUS (P), %	< 0.3	0.3 - 0.5 >	0.5
POTASSIUM (K), %	< 1.5	1.5 - 3.5 >	3.5
CALCIUM (Ca), %	< 0.70	0.70 - 2.0 >	2.0
MAGNESIUM (Mg), %	< 0.30	0.30 - 1.0 >	1.00
SULFUR (S), %	< 0.25	0.25 - 0.70 >	0.70
IRON (Fe), PPM	< 100	100 - 300 >	300
COPPER (Cu), PPM	< 3.0	3.0 - 25 >	25.0
BORON (B), PPM	< 30	30 - 100 >	100
MANGANESE (Mn), PPM	< 45	45 - 300 >	300
ZINC (Zn), PPM	< 25	25 - 100 >	100

PPM = PARTS PER MILLION - DRY WT.

Comparative Analysis

- Suspect a nutritional problem?
- Test media and plant tissue from healthy plants and symptomatic plants
- Comparing the results will give you the best idea of the nutritional problem as subtle differences in nutrient levels may have a great impact on plant nutrition.
- Run comparative media and tissue samples at the same time for best results in diagnosing the problem.
- Have a water analysis on hand for reference.
- Visual inspection of plant symptoms will also give a great guide to nutritional problems.

Mix your own or Pre-formulated

- Mixing your own offers more control
- Must have high level of expertise in nutrition & fertilizations to mix your own & succeed
- Many more formulations available now
- Many fertilizer companies will formulate for your own use

Fertilizer Material	Percent Analysis	Potting Soil per 3 bushels	Potted Plants tsp/ 6" pot	lbs Bench Crops per 100 sq ft	200 ppm oz/100 gal	Standard[1] oz/5 gal	Standard[1] oz/100 gal	Relative Availability	Equivalent acidity[3]	Equivalent basicity[4]
Nitrogen Fertilizers (acid residue)				lbs.	nitrogen					
Ammonium nitrate	33-0-0	--	1/4	1/2	8 3/4	1	20	Rapid	60	--
Ammonium sulfate	20-C-0	--	1/2	1	13 1/4	1 1/2	32	Rapid	110	--
Urea	46-0-0	--	1/4	1/2	6	3/4	15	Rapid	80	--
Nitrogen Fertilizers (alkaline residue)										
Calcium nitrate[2]	16-0-0	--	1/2	1	17	1 1/2	32	Rapid	--	21
Sodium nitrate	16-0-0	--	1/2	1	17	1 1/2	32	Rapid	--	29
Potassium nitrate	13-0-44	--	1/2	1	20 3/4	2 1/2	36	Rapid	--	23
Phosphorus Fertilizers (acid residue)					phospherus					
Mono-ammonium phosphate	11-48-0	--	--	1 1/3 ✓	12 3/4(105 N)	2 1/2	33	Rapid	55	--
Di-ammonium phosphate	21-53-0	--	--	1	11 1/2(180 N)	1	20	Rapid	74	--
Phosphorus Fertilizers (neutral residue)										
Superphosphate	0-20-0	4" potful	--	5	--	--	--	Slow	0	0
Treble Superphosphate	0-45-0	3" potful	--	2	--	--	--	Slow	0	0
Potassium Fertilizer (alkaline residue)					potassium					
Potassium nitrate	13-0-44	--	1/2	1	7 1/4(70 N)	2 1/2	36	Rapid	--	23
Potassium Fertilizers (neutral residue)										
Potassium chloride	0-0-60	--	1/2	1	4	2 1/2	25	Rapid	0	0
Potassium sulfate	0-0-48	--	1/2	1	6 3/4	2 1/2	36	Rapid	0	0
Secondary Nutrients										
Calcium sulfate (gypsum)	29Ca,20S	3-4" potful	--	3-5 lb	--	3/4	8-16	Slow	--	--
Magnesium sulfate (epsom salts)	10 Mg	--	--	2-5 lb	--	3/4	8-16	Medium	--	--
Micronutrients (see text)										
Boric acid	17 1/2 B	--	--	1/2-1 oz	--	1 1/2 gr	1 oz	Medium	--	--
Chelated iron	12 Fe	--	--	1 oz	--	1/4	5 oz	Rapid	--	--
Copper sulfate	25 Cu	--	--	1/2-1 oz	--	--	1/2-1 oz	Slow	--	--
Iron sulfate	20 Fe	1 oz	--	8-16 oz	--	2 1/2	50	Medium	--	--
Manganous sulfate	25-65 Mn	--	--	1/4-1/2 oz	--	1 1/2 gr	1 oz	Slow	--	--
Zinc sulfate	22-35 Zn	--	--	1/4-1/2 oz	--	1 1/2 gr	1 oz	Slow	--	--
Soil Acidifiers (to decrease pH of sandy loam one unit; increase the rate by 1/3 to 1/2 for heavy and organic soils)										
Phosphoric acid	85%	--	--	--	--	--	1 1/2 fl oz	Medium	--	--
Iron sulfate	20	3 3/4 oz	--	32 oz	--	2 1/2	50	Medium	--	--
Sulfur	95	3/4 oz	--	8 oz	--	--	--	Slow	--	--

1 Standard rates suggested are full rate applications; when fertilizer is applied with every watering a less concentrated solution of 200 ppm nitrogen and potassium is suggested. Avoid use of fertilizers with more than 50% of nitrogen in the ammonium form in winter.

2 Use 1/2 pound citric acid per 100 pounds calcium nitrate to prevent thickening of the solution.

3 Number of parts by weight of calcium carbonate required to neutralize the potential soil acidifying power of 100 parts of the fertilizer material.

4 Number of parts by weight of calcium carbonate that correspond in acid-neutralizing power to 100 parts of the fertilizer material.