Greenhouse Media, Fertility and Irrigation

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Functions of Media

- To provide plant support
- To serve as a reservoir for mineral nutrients
Functions of Media

- To hold water in such a way that it is available to plants
- To allow gas exchange between surface and roots
  - Oxygen in and carbon dioxide out
Grower Control

- Only providing plant support is a given function of the substrate
- All other functions under grower control
Balance of Air and Water

Good media

Compacted

W.C. Fonteno
Physical Media Components

- **Organics:** peat moss, bark, whole trees, coconut coir, composts and other organics

- **Inorganics:** field soil, sand, vermiculite, perlite, polystyrene foam, rock wool
Physical Media Components

Texture – size and distribution of particles in mix

- Affects water retention and porosity
- Finer texture has smaller particles, smaller pores and therefore greater water retention
- Need balance for adequate porosity
Physical Components

- Structure – particle combinations into larger aggregates to create air spaces (pores)
- Easily destroyed by rough handling during media preparation or use
  - Do not pack pots
  - Do not stack pots
Composition of Media Mix

- Affects amount of air, water and nutrients that can be held in the pot
- Affects the chemistry of the media (pH)
- Determines irrigation and fertilization practices
Substrate Porosity

- 1Peat:1Rockwool: 92%
- 1Peat:1Vermiculite: 87%
- 3Bark:1Peat:1Sand: 70%
- Mineral soil: 50%

Percent Porosity of Substrate
What Affects Air : Water?

- Physical components of mix
- Handling of mix and pots
- Irrigation practices
- Pot size and shape
Factors Affecting Air and Water Status

Container Filling
Moisture Content
Mixing Time
Wetting Agents

SUBSTRATE HANDLING

SUBSTRATE

CONTAINER

WATERING PRACTICES

Pots
Flats
Plugs

Top Watering
Subirrigation
Pulse Watering
Leaching Fraction

WC Fonteno
Drainage

Gradient of moisture content in pot

Least at top

Most at bottom

Bottom often saturated
# Container Size

Peat : Vermiculite Media

<table>
<thead>
<tr>
<th>%</th>
<th>6-inch</th>
<th>4-inch</th>
<th>48</th>
<th>288</th>
<th>648</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>20</td>
<td>13</td>
<td>8</td>
<td>3</td>
<td>0.5</td>
</tr>
<tr>
<td>Water</td>
<td>67</td>
<td>74</td>
<td>79</td>
<td>84</td>
<td>86.5</td>
</tr>
<tr>
<td>Solid</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
</tr>
</tbody>
</table>

WC Fonteno
Proper Air : Water Ratio

Grower must:
- Select appropriate mix
- Properly manage that mix for proper growth
Mixing Your Own Media?

- Based on management and economics
- Mixing costs: equipment, raw materials, costs of skilled labor, consequences of error, quality control testing
- Less than 100,000 sq.ft.??
  Cheaper to Buy!!
Commercial Soil-less Media

- Uniform
- Consistent
- Free of contamination
- Automated, appropriate mixing and handling
Commercial Soil-less Media

- Custom blends available
- Evaluate economics
  - Even large operations may be better off buying in the mix
Commercial Formulations

- Too numerous to list
- Use a reputable company
  - Quality assurance program
  - Technical assistance
  - Testing lab
- Consider availability and shipping costs
Handling of Media Mixes

- Rough handling or packing breaks down media structure
  - Reduces pore size
  - Reduces water penetration and availability
  - Increases water retention
  - Reduces aeration
Filling Flats or Pots

- Avoid compaction
- Use moist media (50%)
- Overfill containers
- Brush off excess
Filling Flats or Pots

- Avoid compaction
- Dibble
- Water in plants
Summary: Root Zone Management

Create optimum root environment by:
  - Buying or blending appropriate mix
  - Properly filling pots/flats
  - Properly watering in

All under grower control!!
Reading a Fertilizer Label

- Formulation
- Analysis
- Potential acidity or basicity
- Recommended rates
- Mixing instructions
Fertilizer Analysis

Percentages of N-P-K

<table>
<thead>
<tr>
<th>Dilution Ratio</th>
<th>50 PPM Nitrogen (EC=.33)</th>
<th>100 PPM Nitrogen (EC = .65)</th>
<th>200 PPM Nitrogen (EC = 1.30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:15 HOZON</td>
<td>.5 Ounces</td>
<td>1.0 Ounces</td>
<td>2.0 Ounces</td>
</tr>
<tr>
<td>1:100 INJECTOR</td>
<td>3.38 Ounces</td>
<td>6.75 Ounces</td>
<td>13.5 Ounces</td>
</tr>
<tr>
<td>1:200 INJECTOR</td>
<td>6.75 Ounces</td>
<td>13.5 Ounces</td>
<td>27.0 Ounces</td>
</tr>
</tbody>
</table>

To convert ounces/gallon to grams/liter, multiply by 7.5.
Dissolves quickly in hot water, limit of solubility 4.0 lbs./gallon.
Commercial use suggestions.
Guaranteed Analysis

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Guaranteed Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Nitrogen (N)</td>
<td>20%</td>
</tr>
<tr>
<td>7.84% Ammoniacal Nitrogen</td>
<td></td>
</tr>
<tr>
<td>12.16% Nitrate Nitrogen</td>
<td></td>
</tr>
<tr>
<td>Available Phosphate (P&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;5&lt;/sub&gt;)</td>
<td>10%</td>
</tr>
<tr>
<td>Soluble Potash (K&lt;sub&gt;2&lt;/sub&gt;O)</td>
<td>20%</td>
</tr>
<tr>
<td>Magnesium (Mg) (Total)</td>
<td>0.15%</td>
</tr>
<tr>
<td>0.15% Water Soluble Magnesium (Mg)</td>
<td></td>
</tr>
<tr>
<td>Boron (B)</td>
<td>0.02%</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>0.01%</td>
</tr>
<tr>
<td>0.01% Chelated Copper (Cu)</td>
<td></td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>0.10%</td>
</tr>
<tr>
<td>0.10% Chelated Iron (Fe)</td>
<td></td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>0.056%</td>
</tr>
<tr>
<td>0.056% Chelated Manganese (Mn)</td>
<td></td>
</tr>
<tr>
<td>Molybdenum (Mo)</td>
<td>0.01%</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>0.0162%</td>
</tr>
</tbody>
</table>

- Nitrogen form
- Mg and micronutrients
N Effects on Fertility Program

- **N form affects frequency of application**
  - Urea/ammonia are “storage” forms
    - Slower breakdown, less leaching
    - Media type (bacterial process)

- **Low temperatures require more nitrate**
  - Slow conversion of ammonia to nitrate
N Effects on Plant Growth

- Nitrogen form affects plant growth
  - Ammonia = lush
  - Nitrate = compact

- Plant tolerances for ammonia differ (<40%)
Common Fertilizers

◆ Peters 20-20-20 General Purpose
  – Very acidic formula
  – 70% N is in ammoniacal form
  – Contains micronutrients

◆ Peters 20-10-20 Peat-Lite
  – Acidic formula
  – 39% N is in ammoniacal form
  – Contains greater amounts of micronutrients
### Additional Info on Label

**Peters Professional® 20-10-20 Peat-Lite Special®**
**Water Soluble Fertilizer**

*(Suggestions for Commercial Growers)*

<table>
<thead>
<tr>
<th>100 ppm N Solution Contains the Following Elemental ppm</th>
<th>Continuous Feeding ppm N (Constant Liquid Feeding)</th>
<th>Periodic Feeding ppm N (Pulse Feeding)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Crop Type</strong></td>
<td><strong>Bedding Plants</strong></td>
<td><strong>200–250</strong></td>
</tr>
<tr>
<td><strong>Ammonium-N</strong> (NH₄ – N)</td>
<td>100–150</td>
<td></td>
</tr>
<tr>
<td><strong>Nitrate-N</strong> (NO₃ – N)</td>
<td>60.8</td>
<td></td>
</tr>
<tr>
<td><strong>Phosphorus</strong> (P)</td>
<td>21.8</td>
<td></td>
</tr>
<tr>
<td><strong>Potassium</strong> (K)</td>
<td>83.0</td>
<td></td>
</tr>
<tr>
<td><strong>Calcium</strong> (Ca)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Magnesium</strong> (Mg)</td>
<td>0.750</td>
<td></td>
</tr>
<tr>
<td><strong>Boron</strong> (B)</td>
<td>0.100</td>
<td></td>
</tr>
<tr>
<td><strong>Iron</strong> (Fe)</td>
<td>0.500</td>
<td></td>
</tr>
<tr>
<td><strong>Manganese</strong> (Mn)</td>
<td>0.280</td>
<td></td>
</tr>
<tr>
<td><strong>Molybdenum</strong> (Mo)</td>
<td>0.050</td>
<td></td>
</tr>
<tr>
<td><strong>Zinc</strong> (Zn)</td>
<td>0.081</td>
<td></td>
</tr>
<tr>
<td><strong>Containerized Woody Plants</strong></td>
<td>50–100</td>
<td>200–350</td>
</tr>
<tr>
<td><strong>Cut Flowers</strong></td>
<td>175–225</td>
<td>300–450</td>
</tr>
<tr>
<td><strong>Potted Chrysanthemums</strong></td>
<td>250–300</td>
<td>350–400</td>
</tr>
<tr>
<td><strong>Potted Easter Lilies</strong></td>
<td>250–300</td>
<td>350–400</td>
</tr>
<tr>
<td><strong>Potted Tropical Foliage</strong></td>
<td>150–200</td>
<td>250–300</td>
</tr>
<tr>
<td><strong>Potted Geraniums</strong></td>
<td>250–300</td>
<td>350–400</td>
</tr>
<tr>
<td><strong>Potted Poinsettias</strong></td>
<td>200–300</td>
<td>375–400</td>
</tr>
<tr>
<td><strong>Plugs (All Types)</strong></td>
<td>50–125</td>
<td>175–225</td>
</tr>
</tbody>
</table>
Select Fertilizer Formulation and Analysis

- Crop and growing stage
  - Nitrate vs. ammonia
  - Micronutrient availability
- Water quality (alkalinity)
- Media pH management
Fertilizer Injectors or Proportioners

Inject specific amount of concentrated fertilizer per increment of irrigation water that passes through the injector to give final fertilizer solution.
Fertilizer Injector Ratio

- Volumetric ratio of stock solution to dilute solution
  - Ex. a 1:100 injector delivers 100 gal of dilute fertilizer solution for each gal of concentrated stock solution
- Available 1:5 to 1:500
  - Most common 1:16 and 1:100
- Determines the concentration of the fertilizer stock solution
# Mixing Instructions on the Label

Ounces of Peters Professional 20-10-20 Per Gallon of Concentration

<table>
<thead>
<tr>
<th>ppm</th>
<th>Injector Ratios</th>
<th>E.C. mmhos/cm</th>
</tr>
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<tbody>
<tr>
<td>Nitrogen</td>
<td>1:15</td>
<td>1:100</td>
</tr>
<tr>
<td>50</td>
<td>0.50</td>
<td>3.38</td>
</tr>
<tr>
<td>100</td>
<td>1.00</td>
<td>6.75</td>
</tr>
<tr>
<td>150</td>
<td>1.50</td>
<td>10.13</td>
</tr>
<tr>
<td>200</td>
<td>2.00</td>
<td>13.50</td>
</tr>
<tr>
<td>250</td>
<td>2.50</td>
<td>16.88</td>
</tr>
<tr>
<td>300</td>
<td>3.00</td>
<td>20.25</td>
</tr>
<tr>
<td>350</td>
<td>3.50</td>
<td>23.63</td>
</tr>
<tr>
<td>400</td>
<td>4.00</td>
<td>27.00</td>
</tr>
</tbody>
</table>
What if you are not using injector?

Divide 1 oz by 15 to reduce from 1 gal stock to a ready to use at 100 ppm N

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<tr>
<th>DILUTION RATIO</th>
<th>50 PPM NITROGEN</th>
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<tr>
<td></td>
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TO CONVERT OUNCES/GALLON TO GRAMS/LITER, MULTIPLY BY 7.5
Dissolves quickly in hot water. Limit of solubility 4.0 lbs./gallon
Commercial Use Suggestions: Use at a rate of 1 oz per gallon
Suggested Concentration in ppm Nitrogen: 100 ppm N
Mixing Fertilizer Stock Solutions

- Accurately weigh and measure fertilizer and water
- Add fertilizer to partially filled stock tank
- Add (warm) water to desired volume
Components of Water Quality

- Water sources
- pH
- Alkalinity
- EC (electrical conductivity)
- Specific ions
Irrigation Water Tests

- Start with a qualified lab
  - Commercial labs
  - Fertilizer companies
  - Media companies
- Not a drinking water test
- Labs include interpretation information
Irrigation Water pH

- pH is a measure of the acidity or basicity of the water
- Measurement of the concentration of the hydrogen ion in the solution
  - Scale 1 to 14 with 7 as neutral
- Preferred range 5.4 to 6.8
Water Alkalinity: definitions

- Measure of water’s capacity to neutralize acids
- Establishes the buffering capacity of the water
- Measured by ppm of bicarbonate ions (Ca, Na, Mg bicarbonate salts) + carbonate ions (Ca carbonate salts)
Irrigation Water Alkalinity

- Prefer 60 to 100 ppm bicarbonates for greenhouse and nursery crops
- High alkalinity is like adding lime with each irrigation
  - Raises media pH
  - Countered by acidic fertilizers
Irrigation Water Alkalinity

- Low alkalinity – limited ability to buffer effects of fertilizers
  - Acidic fertilizers rapidly reduce media pH
  - Basic fertilizers rapidly raise media pH
How Can You Manage High Water Alkalinity?

- Counter high alkalinity by acid injection
  - To manage media pH and nutrient availability
  - Based on a good laboratory water test
  - Use the NCSU Alkalinity Calculator for acid injection recommendations (under floriculture links)

http://www.floricultureinfo.com/
EC (electrical conductivity)

- Electrical conductivity (EC) is determined by total dissolved salts (TDS)
- Measures salinity (sum of all the ionized dissolved salts)
Irrigation Water EC

- **Upper limits**
  - Greenhouse crops – 2.0 mS/cm
  - Nursery crops – 2.0 mS/cm

- **Preferred ranges**
  - Greenhouse crops – < 0.75 mS/cm
  - Nursery crops – < 1.25 mS/cm
Specific Ion Limitations:
Greenhouse and Nursery

- Na – 70 ppm
- Cl – 70 ppm
- B – 0.5 ppm
- F – 1.0 ppm
- Mg – Ca: ratio 5 Ca to 1 Mg (ppm)
Media Interactions with Substrate Solution Chemistry

- **Components of media**
  - Peat, pine bark tend to acidify solution

- **Media additives**
  - Initial lime added to media to adjust starting pH to 5.5 to 6.5
  - Prefer pH 5.4 to 6.3 for substrate solution

- **Media pH is critical to nutrient availability**
Media pH Affects Nutrient Availability – Especially for Micronutrients
Preferred pH Ranges for Crops
Irrigation Systems

- Hand watering
- Microtube or drip
- Boom or sprinkler
- Subirrigation:
  - Ebb/flow
  - Trough
  - Capillary mat
Hand Watering – Advantages

- Easiest, cheapest set-up
- Good for retail or gh with small numbers of many pot sizes
- Permits scouting
Hand Watering – Disadvantages

- High labor cost
- Lower quality plants produced?
- Compacts substrate
- Disease incidence higher
- Greater amount of water used and perhaps running off
- Uncomfortable, messy and tedious
Microtube/drip – Advantages

- Produces high quality plants
- Little substrate compaction
- More water efficient
- Less disease spread
- Low installation costs
Microtube/drip – Disadvantages

- Time-consuming to insert tubes
- Must check daily for dry plants (esp retail settings)
- Less water efficient than re-circulating systems
Boom/sprinkler – Advantages

- Irrigate large areas at once
- Low cost for sprinkler installation
- Moderate cost for boom irrigation
Boom/sprinkler – Disadvantages

- Crop specific
- Uses large amount of water
- May produce runoff
- Uniformity may be poor
- Increase foliage diseases
New Designs to Reduce Drip
Ebb/Flow – Advantages

- Produces high quality plants
- No substrate compaction
- Very water efficient
- Low potential for foliage diseases
Ebb/Flow – Disadvantages

- High installation costs
- Salts accumulate in top of pots
- Not feasible with very large pots
- Trough spacing not flexible
- May have high potential for root rots (recirculating system)
Automated Irrigation System

- Properly designed system:
  - Water is more easily applied when needed
  - In the quantity required
  - Applied uniformly to the crop
Benefits of Automation

- Labor savings (35% to 60%)
- Reduced water usage (30%)
- Reduced fertilizer costs (25%)
- More uniform plant growth
Resources

- Media components
  - NCSU Substrates/Fertility (Bailey, Fonteno & Nelson)

- Fertilizer components
  - GOCP Manual Fertility Chapter

- Water quality
  - GOCP Manual for statewide distribution
For more information

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http://www.hort.vt.edu/floriculture