Greenhouse Management for the Hobby Greenhouse

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Extension Specialist, Greenhouse Crops

Management Basics
- Environmental control
- Media, water, fertilizer
- Optimizing plant health

Greenhouse Environment
- Manage light levels and quality
- Temperature
- Air quality and movement
- Relative humidity

Light Intensity
- Full sun ~10,000 fc
- Lose 30% to 50% with greenhouse covering, structures
- High light intensity increases branching and reduces stem stretch

Supplemental Lighting
- Increase light intensity
- Winter production
- High value crops: cuts, plugs, potted crops
- Costs of installation: $3.80 to $6.10/sf

Light Quality
- Light color
- Red:far red ratio
- Incandescent bulbs
  - More far red than red light
  - More stretch
- HID lights less stretch
Plant Spacing Affects Light Quality

- Leaves act as light filters
  - Absorb red so light below is higher in far red; produces stretch
- Pot to pot spacing
- Overhead baskets

Photoperiod

- Daylength = number of hours of light in 24-hr period
- Varies over growing season
- Affects growth and flowering (schedule)

Temperature

- Plants have optimums and minimums for growth
- Lower temperatures reduce growth rate
- Excessive heat limits plant growth

Ventilation

- Bringing in outside air
  - For temperature control
  - For humidity control
  - For fresh air
  - Carbon dioxide required for photosynthesis and growth

Air Circulation

- Keep the air moving
- Fans or tubes
- Keep leaf surfaces dry
- Temperature should be uniform through-out the greenhouse
- Promotes uniform growth
- Reduces disease

Media, Fertilizer and Water
Functions of Media
- To provide plant support
- To serve as a reservoir for mineral nutrients
- 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

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

<table>
<thead>
<tr>
<th>Mix Description</th>
<th>Percent Porosity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1Part:1Part Rockwool</td>
<td>92%</td>
</tr>
<tr>
<td>1Part:1Part Vermiculite</td>
<td>87%</td>
</tr>
<tr>
<td>3Parts:1Part Sand</td>
<td>70%</td>
</tr>
<tr>
<td>Mineral soil</td>
<td>50%</td>
</tr>
</tbody>
</table>

Drainage

<table>
<thead>
<tr>
<th>Gradient of moisture content in pot</th>
<th>Least at top</th>
<th>Most at bottom</th>
<th>Bottom often saturated</th>
</tr>
</thead>
</table>

Container Size

<table>
<thead>
<tr>
<th>Peat : Vermiculite Media</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>

Proper Air : Water Ratio

- Grower must:
  - Select appropriate mix
  - Properly manage that mix for proper growth

Commercial Soil-less Media

- Uniform
- Consistent
- Free of contamination
- Automated, appropriate mixing and handling
- Use a reputable company
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

Compaction
- Stacked trays cause compaction
- Compaction leads to non-uniform watering

Balance of Air and Water
- Good media
- Compacted
Summary: Root Zone Management

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

All under YOUR control!!

Reading a Fertilizer Label

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

Fertilizer Analysis

- Percentages of N-P-K

Guaranteed Analysis

- 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)

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 a specific amount of concentrated fertilizer per increment of irrigation water that passes through the injector to give the 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

<table>
<thead>
<tr>
<th>Ounces of Peters Professional 20-10-20 Per Gallon of Concentration</th>
<th>E.C.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ppm</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>------</td>
<td>----------</td>
</tr>
<tr>
<td>50</td>
<td>0.50</td>
</tr>
<tr>
<td>100</td>
<td>1.00</td>
</tr>
<tr>
<td>150</td>
<td>1.50</td>
</tr>
<tr>
<td>200</td>
<td>2.00</td>
</tr>
<tr>
<td>250</td>
<td>2.50</td>
</tr>
<tr>
<td>300</td>
<td>3.00</td>
</tr>
<tr>
<td>350</td>
<td>3.50</td>
</tr>
<tr>
<td>400</td>
<td>4.00</td>
</tr>
</tbody>
</table>
Mixing Instructions on the Bag

- 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

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 0 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

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/

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

EC (electrical conductivity)

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

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

Preferred pH Ranges for Crops

<table>
<thead>
<tr>
<th>Species</th>
<th>pH Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easter Lily</td>
<td>4.4-5.5</td>
</tr>
<tr>
<td>Celosia</td>
<td>4.5-5.5</td>
</tr>
<tr>
<td>Dianthus</td>
<td>4.6-5.5</td>
</tr>
<tr>
<td>Geranium</td>
<td>4.7-5.5</td>
</tr>
<tr>
<td>Marigold, African</td>
<td>4.8-5.5</td>
</tr>
<tr>
<td>Hydrangea (Pink)</td>
<td>4.9-5.5</td>
</tr>
<tr>
<td>General Crops</td>
<td>5.0-5.5</td>
</tr>
<tr>
<td>Pansy</td>
<td>5.5-6.0</td>
</tr>
<tr>
<td>Petunia</td>
<td>5.6-6.0</td>
</tr>
<tr>
<td>Salvia</td>
<td>5.7-6.0</td>
</tr>
<tr>
<td>Snapdragon</td>
<td>5.8-6.0</td>
</tr>
<tr>
<td>Vinca</td>
<td>5.9-6.0</td>
</tr>
<tr>
<td>Hydrangea (Blue)</td>
<td>6.0-6.5</td>
</tr>
<tr>
<td>Azalea</td>
<td>6.1-6.5</td>
</tr>
</tbody>
</table>

Hand Watering

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

Irrigation Systems

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

Microtube/drip

- Produces high quality plants
- Little substrate compaction
- More water efficient
- Less disease spread
- Low installation costs
Subirrigation
- Produces high quality plants
- No substrate compaction
- Very water efficient
- Low potential for foliage diseases

General Guidelines for Growing Bedding Plants

<table>
<thead>
<tr>
<th>Light</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>5,000 - 6,000 fc</td>
<td>60 - 70° Night</td>
</tr>
<tr>
<td></td>
<td>+15° Sunny days</td>
</tr>
<tr>
<td></td>
<td>+10° Cloudy days</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water</th>
<th>Nutrition</th>
</tr>
</thead>
<tbody>
<tr>
<td>To prevent stress</td>
<td>CLF: 100-200 ppm N</td>
</tr>
<tr>
<td>To induce stress</td>
<td>Wkly: 500-600 ppm N</td>
</tr>
<tr>
<td>Control size</td>
<td></td>
</tr>
</tbody>
</table>

Optimizing Plant Health
All environmental elements in balance
- As they affect the plant
- In relation to one another
- Proper balance of soil nutrients and acidity
- Ample space (roots and shoots)
- Freedom from pests and diseases

Plant Stress
When one or more of these elements is out of range
- Results in reduced plant health
- Chronic vs. acute stress

Chronic Stresses
- Insufficient or excessive water
- Insufficient or excessive light
- High temperatures
- Cold temperatures
- Nutritional imbalances
- Improper soil pH

Stress Management
- Good environmental awareness
  - Be aware of interactions in environmental conditions
- Learn to recognize plant decline early
  - Know the crop requirements
  - Time to reverse the imbalance
Nutritional Problems

- Related to environmental conditions
- Related to media conditions
  - Water
  - pH
  - Soluble salts
- Law of limiting element

Nutritional Problems

- Many resources for leaf symptoms
- For floriculture crops – NCSU
  - [www.floricultureinfo.com](http://www.floricultureinfo.com)
  - Click on Cultural topics, then Nutrition & Fertilizers, then Nutrient Deficiency Series

Insect and Disease Management

- Verify that your purchases are clean
- Know your plant
- Know what diseases or insect pests to expect
  - History of greenhouse and crop
- Know the pests in your area
- Learn about these pests (id and life cycle)
- Watch the weather
- Know your control options and have them on hand

Monitoring Plants

- Scouting
  - inspect plants on a regular schedule
- Sticky Traps
  - Yellow for most pests
  - Proper Placement
- Don’t buy your problems

Good Sanitation is Critical

Eliminate ALL Weeds

Acute Stresses (injuries)

Environmental/cultural problems
Pesticide phytotoxicity or overapplication
Mechanical damage
Learn from your mistakes!!
Environmental/Cultural Causes of Disorders
- Temperature
  - Cold damage
  - High temperature stress
- Light
- Water
- Nutrition

Types of Chemical Disorders
- Characteristic chemical responses
- Overdoses of intentional sprays
- Improper spray techniques
- Use of improper chemicals
- Drift or overspray of chemicals onto sensitive crops

Phytotoxicity from Insecticides
- Improper spray techniques
  - Too close with aerosols
  - Environmental conditions increase sensitivity
- Using improper chemical
  - Know the phyto symptoms

Acute Phytotoxicity
- Look at the pattern of the damage
  - A spray pattern?
- Did the damage show up “overnight”?
  - What chemicals were recently applied?

Herbicides
- Use of improper chemicals
  - Volatilization of pre-emergents or non-labeled herbicides
- Overspray or drift

Avoiding Chemical Disorders
- Use appropriate pesticide rates and application methods to avoid overdose
- Pay attention to spray techniques and environmental conditions
- Use only labeled chemicals
- Be very careful using herbicides around crops or outside vented greenhouses
Contamination – Gases

- Propane or natural gas leaks

Incomplete combustion – gases

- Cupping of leaves
- Ethylene/gas injury

Diagnosis of Plant Problems

- Cultural requirements of the crop
  - Are they being met?
  - What are anticipated problems?
- Symptoms
  - Exactly, detailed
  - Extent of symptoms (surrounding crops?)
  - When did symptoms appear?

Diagnosis con’t.

- List probable causes
  - Environmental conditions
  - Insect or disease organisms
  - Pesticide applications
- List possible remedies
- What are the practical remedies?
- When can remedy be implemented?

Resources

- Ball Pest & Disease Manual (Powell and Lindquist, 1997 2nd ed.)
- Integrated Pest Management for Bedding Plants (Cornell’s New York State IPM Program, 2000)
- Ball Field Guide to Diseases of Greenhouse Ornamentals (Daughtrey and Chase, 1992)
- Pests & Diseases of Herbaceous Perennials (Gill, Clement, and Dutky, 1999)
- NCSU Nutrient Disorder Guides (Whipker et al. 2001)
- PICT Guide of Bedding Plant Disorders (NCSU, 2002)

For more information

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