Soil 4234 Guest Lecture

Soil Fertility in Potted Horticulture Crops

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Determine Water Quality

- Prior to selecting a site for a new business and periodically thereafter, test water
  - Seasonally
  - Over time
  - Among different locations
- Test water for…
  - Nutrient content
  - EC
  - pH
  - Total alkalinity

Electrical Conductivity (EC)

- A measure of the soluble salt level or salinity
  - The higher the EC, the higher the salinity.
  - Water with low EC (0.1-0.5 dS/m or 100-500 μS/cm) will give the grower the greatest number of irrigation and nutritional options.
  - For more information, see US Salinity Laboratory's website

    http://www.ars.usda.gov/main/site_main.htm?modecode=53102000

Macronutrients:

- Macronutrient: N
  Nitrogen (150-300 ppm)
  - Recommendations are often based on the amount of nitrogen to be supplied.
- Macronutrient: P
  Phosphorus (75-150 ppm)
- Macronutrient: K
  Potassium (150-300 ppm)

Organic Fertilizer

- Are made from not only plant and animal residues but also mined minerals
  - compost, animal manure, blood/bone meal

- Limitation:
  - Low nutrient analysis, lower pH, nutrient release is too slow and unknown, and too little nutrients are released
  - To equal the fertility supplied by 100 pounds of 10-5-10 (N-P_2O_5-K_20), 1 ton of cow manure put be applied

Pre-plant Fertilization

1. Controlled-release fertilizer (CRF) incorporated into the potting media that is intended to last the entire crop cycle

   -or-

2. Small amount of water soluble fertilizer to serve as a “starter fertilizer,” lasting for only about the first two weeks

Controlled-Release Fertilizers (CRF)

- Reduce labor costs and waste associated with leaching
- More efficient than fertigation since less is lost through leaching
- May continue to provide a low amount of post harvest nutrition while in the consumer's home or on display

Disadvantages of CRF

- Grower loses control of the fertilization program because once the CRF is incorporated into the potting media, it cannot easily be leached out.
  - Thus the grower cannot easily modify the fertilization program to meet the needs of the weather or consumer demand.
- Also, CRFs are not as effective in winter when temperatures are lower, as the rate of release is directly related to temperature.

Types of CRFs

- Slowly soluble and plastic-coated fertilizers are most commonly used to provide macronutrients.

- Fritted fertilizers and impregnated clays are typically used to provide micronutrients.

Plastic-Coated Fertilizers

- Hygroscopic fertilizers, such as Osmocote®, Nutricote®, etc., attract water through pores in the plastic coat.
  - Release rate is controlled by pore size and thickness of the plastic coat.
  - Increasing temperature increases release rate.
  - Longevity ranges from 3 to 14 months, based on average media temperature of 70°F, and is specified by the manufacturer.
  - Increases in “available water” will NOT affect release rate.
  - Should NOT be heat pasteurized!

Impregnated Clays

- Nutrients, commonly micronutrients, are attached to baked clay particles from which they slowly leach.
    - Esmigran®
  - Increasing temperature increases release rate.
  - Increasing moisture increases release rate.
  - Can be heat pasteurized

Fertigation

- Fertigation is the application of running water-soluble fertilizer through the irrigation system.
  - Constant Liquid Fertilization (CLF) is the application of nutrients at every irrigation.
    - Plants that are growing faster and thus using more water will receive more fertilizer.
    - CLF nutrient levels may be insufficient when weather is cloudy or when cuttings/seedlings have just been transplanted.

Nutritional Requirements

- Some plants require more fertilizer than others, *e.g.*
  - Poinsettias (*Euphorbia pulcherrima*) require high levels of nutrients.
  - African violets (*Saintpaulia ionantha*) require low levels of nutrients.
- Needs can be balanced throughout the greenhouse range by…
  - Applying at the high rate and leaching low-demand plants more frequently.
  - Applying at the low rate and supplementing the high-demand plants with slow-release fertilizer.

Variables that Influence Nutrient Availability

- Irrigation frequency
- Leaching fraction—the percentage of water applied that runs out the bottom of the container
- Season—higher rates in summer
- Media—lower fertilizer rate with higher CEC
- Stage of growth—higher rates at beginning of crop cycle

Water-Soluble Micronutrients

- If controlled-release micronutrients have not been incorporated into the media prior to planting, water-soluble micronutrients must be applied.
  - STEM—**S**oluble **T**race **E**lement **M**ixture
  - Chelated forms of micronutrients remain available at various pHs.

Mixing Water-Soluble Fertilizers

- Although small quantities can be mixed and applied with a watering can, injectors and proportioners are commonly used in the greenhouse.
  - Backflow preventer must be installed to protect against fertilizer being drawn back into the water supply line.
  - Greenhouses generally use injectors with a ratio between 1:16 and 1:200.
  - High flow rate injectors are needed for ranges with multiple areas being fertigated simultaneously.

Mixing Fertilizer Components

- Do a “jar test” to ensure there is no incompatibility.
  - Mix the fertilizer components with a sample of irrigation water and allow it to sit for 1-2 hours.
    - If the products are incompatible, precipitate(s) will form or the sample will become cloudy.
  - Do NOT mix fertilizer solutions containing calcium with solutions containing phosphates or sulfates.
    - $Ca(NO_3)_2 + MgSO_4 \cdot 7H_2O$ (Epsom salts) ⌫ insoluble precipitate
- Mistakes are costly and sometimes irrecoverable.

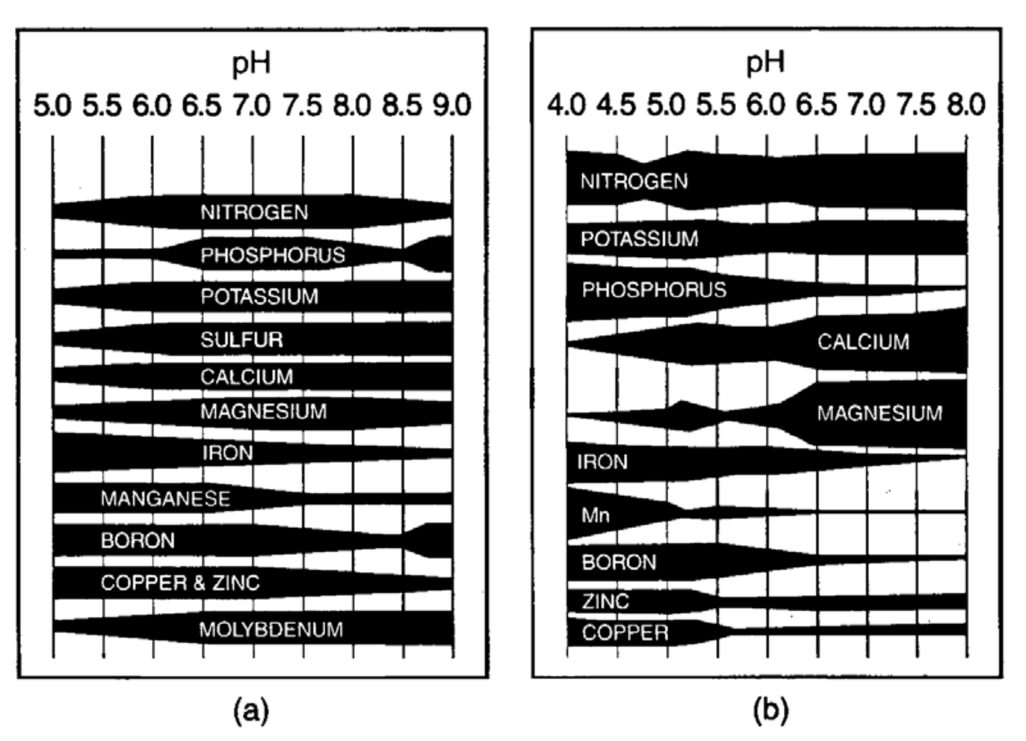
Fertigation Fertilizer Incompatibility Chart

	Urea	Ammonium Nitrate	Ammonium Sulfate	Calcium Nitrate	Potassium Nitrate	Potassium Chloride	Potassium Sulfate	Ammonium Phosphate	Fe, Zn, Cu, Mn Sulfate	Fe, Zn, Cu, Mn Chelate	Magnesium Sulfate	Phosphoric Acid	Sulfuric Acid	Nitric Acid
Urea														
Ammonium Nitrate														
Ammonium Sulfate				X			R							
Calcium Nitrate			X				X	X	X	R	X	X	X	
Potassium Nitrate														
Potassium Chloride							R							
Potassium Sulfate			R	X		R			R		R		R	
Ammonium Phosphate				X					X	R	X			
Fe, Zn, Cu, Mn Sulfate				X			R	X						
Fe, Zn, Cu, Mn Chelate				R				R				R		X
Magnesium Sulfate				X			R	X						
Phosphoric Acid				X						R				
Sulfuric Acid				X			R							
Nitric Acid										X				

X = incompatible, precipitate forms; R = reduced compatibility

pH Affects Nutrient Availability

Soil-based medium | Soilless medium



Peterson, J.C. 1982. Ohio Agricultural Research and Development Center, Research Bulletin 268.

To Increase pH:

- Calcitic or dolomitic limestone is most commonly used to increase media pH prior to planting.
- pH can be manipulated by increased use of basic and/or reduced use of acidic fertilizers.
- Hydrated lime can be applied but with great CAUTION.
  - It can burn foliage.
  - Do NOT use with CRF containing ammonium or with CLF containing >25% ammonium as ammonia gas may be produced!
- Flowable lime is safer to use, but still requires great caution.

To Decrease pH:

- Elemental sulfur can be incorporated prior to planting.
- Iron sulfate can be used before or after planting.
- pH can be manipulated by increased use of acidic and/or reduced use of basic fertilizers.
- Acid injection of the water supply can also be used to lower media pH, especially in areas with highly alkaline water.
  - Use 2-head injector.

Steps for Monitoring Nutrition

1. Visually monitor the health of the crop.
   - However, keep in mind that by the time symptoms appear, damage has already occurred.
   - It typically can take two weeks for a nutritional deficiency/toxicity to appear in the crop.
2. Media Tests
   - Nutrient, pH and EC levels of substrate
3. Tissue Tests
   - Nutrient levels in the plant

Frequency of Testing Substrate pH and EC

- For preventative purposes, samples should be tested…
  - Prior to using a new potting medium
  - Halfway through the crop cycle of any large crop
  - Every 1-2 months if crop is on a year-round rotation or long-term
- Especially valuable crops should be sampled and tested every 2-3 weeks.

PourThru Extraction Method

1. Irrigate the crop before testing.
   - Saturate the potting medium. If using CLF, fertigate as usual.
2. Place saucer under at least five pots 30-60 min after irrigation.
3. Pour enough distilled water on the surface of each pot’s medium to get 50 ml of leachate in each saucer.
   - Do NOT leach more than 60 ml/pot !
   - 4"-6" pots will require ~75 ml of distilled water.
4. Test samples ASAP…no later than 2 hours after collection.
   - Average the values of the samples.

Interpretation of EC in Soilless Media

1:5 Dilution	1:2 Dilution	SME	PourThru	Interpretation
0-0.12	0-0.25	0-0.75	0-1.0	**Very Low**. Insufficient nutrition
0.12-0.35	0.26-0.75	0.76-2.0	1.0-2.6	**Low**. Suitable for seedlings, bedding plants and salt sensitive plants
0.36-0.65	0.76-1.25	2.0-3.5	2.6-4.6	**Normal**. Standard range for most established plants
0.66-0.89	1.26-1.75	3.5-5.0	4.6-6.5	**High**. Reduced vigor and growth may result, particularly during hot weather
0.9-1.10	1.76-2.25	5.0-6.0	6.6-7.8	**Very High**. Injurious symptoms include marginal leaf burn and wilting
>1.1	>2.25	>6.0	>7.8	**Extreme**. Immediate leaching required

EC expressed in mS/cm. North Carolina State University-HIL558

Leaching

- Irrigating twice within a few minutes such that 20%-30% of the applied water runs out the bottom of the pot
- "No-leach" production requires…
  - High quality water
  - Low fertilizer rates
  - Experienced grower

Tissue Analysis of Nutrient Levels

- Harvest ~1 oz of "most recently mature leaf tissue" without petioles, unless specified differently for the given crop.
  - Avoid collecting leaves with media, fertilizer, or pesticide residue.
  - If residue is present, rinse leaves with distilled water, blot, and air dry before submitting to testing lab.

Nutrient Regulations

- “The horticulture and floriculture industries are working with the EPA towards regulating amount of nitrates and phosphorus used in crop production to reduce runoff into groundwater” Greenhouse Grower Mag. June 2008.

- Reduce runoff by using lower rates of fertilizers, switching to CRF, build retention ponds, etc. (See handouts)

Greenleaf Nursery

- Established in 1958
- Located in Park Hill, OK
- 520 acre containerized nursery (3rd largest in the U.S.)
- In 1989 began a Pollution Prevention Program
  - Conversion from liquid to slow release
  - Construct water retention basins

Impact

- They were contributing 22,743 kg/yr of nitrogen and 444 kg/yr of phosphate to the Illinois River Watershed basin (1.1% of total nutrient load to basin)
- Nitrate nitrogen levels have been reduced by 75% since 1989
- Retention basins cost $1.5 million and have a storage capacity of 80 million gallons

Any Questions and/or Comments?