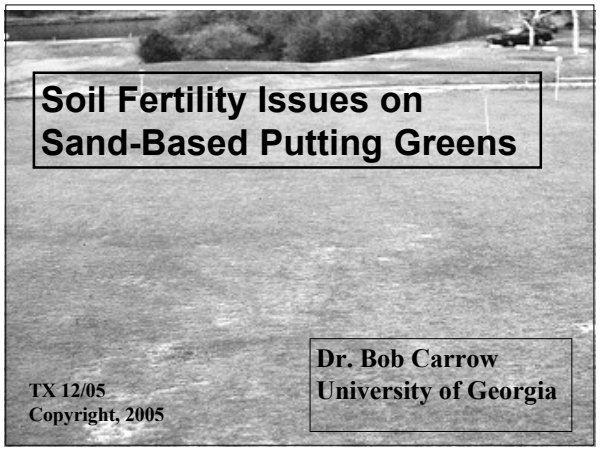

Soil Fertility Issues on Sand-Based Putting Greens

Dr. Bob Carrow
University of Georgia

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Fertilization/Nutritional Challenges on Sand-Based Greens

1. Grass Species and cultivar related.
2. Soil chemical/physical related.
3. Irrigation water source related.
4. Information confusion – products, approaches
5. Combinations of above – "stacking" of problems/challenges.

Bottom line – fertilization must be for several reasons….

Reasons To Fertilize

1. To meet basic plant nutrient needs .
2. To correct imbalances induced by irrigation water; irrigation water treatments; soil treatments/amendments required by irrigation water problems.
3. To correct for leaching of soluble salts –and soluble nutrients.
4. To maximize plant stress tolerances, especially salinity, drought, wear, pests.
5. To alleviate soil chemical problems – low pH, sodic soil, acid sulfate soils, etc.
6. Control plant growth rates and minimize excessive organic matter accumulation.

Fertilization of Sand-Based Greens and Other Sites: #1 Grass Challenges

New Species and Cultivars. Vary in:

- Nutritional needs
- Nutrition-uptake efficiencies
- Rooting abilities – seasonally, depth or distribution, viability
- Tendency to develop excessive OM in surface area
- Use of more salt-tolerant grasses.

Fertilization of Sand-Based Greens and Other Sites: #2 Soil Challenges

Soil Issues (sand-based greens).

- Inherently low CEC – especially in conjunction with high rainfall and/or ultra pure water (ECw < 0.40 dS/m), salt leaching (saline irrigation waters)
- Low OM content
- Excessive OM content
- Salt-affected soils – natural, irrigation water, capillary rise of salts.

New Bermudagrass and Bentgrasses for Greens

Two Problems Associated With OM In the Surface Zone (0 to 2 inch zone):

1. **Low OM content. < 1.5 % OM by weight. Good root system but limited nutrients.**
2. **High/Excessive OM content. > 4 to 5 % OM by weight. Adequate CEC and nutrients but limited roots.**

Both conditions cause fertility/nutritional problems.

Situation: Low CEC/OM Content

Combination of low CEC sands + rapid OM decomposition (little OM contribution to CEC) + irrigation water that is too pure (EC < 0.40 d/Sm) + high rain fall = limited nutrient retention and high leaching of many nutrients.

- **Roots may be present but not nutrients—but nutrient deficiencies ultimately limit rooting.**
- **N, K, Mg, Ca, S, P, Mn, Zn, Fe**
- **Multiple nutrient deficiencies possible.**
- **Other problems--- hydrophobic areas, turf more prone to wear and drought.**

Situation: Low OM Content (continued)

- All nutrients should be spoon-feed.
- N fertilization not responsive if other nutrients are limited.
- Try zeolite. Zeolite with CEC of 150 cmol/kg requires about 225 lbs per 1000 sq. ft. mixed in surface 4.0 inches to raise CEC 1 cmol/kg. Total target CEC in surface 4 inches is 2.5—3.0 cmol/kg.
- Add over time with topdressing at 30 % by volume + 70 % sand.
- Use good stable zeolite—mechanical, weathering stability

Situation: Excessive Surface OM

Excessive OM in the surface zone—can retain excess moisture at the expense of oxygen. Even with cultivation holes through the zone, low oxygen can occur between holes. Oxygen demand is high in summer due to grass and microorganisms. Thus, even a sand rootzone mix may have a low oxygen layer.

- Excessive OM in the surface zone causes limited rooting and root injury due to low oxygen; and more root pathogens.
- Nutrients may be present but roots are not viable for uptake.

Fertilization of Sand-Based Greens and Other Sites: #3 Irrigation Water Challenges

Non-potable irrigation water is becoming more common – recycled, poorer quality aquifers, lower quality surface waters, etc

- Nutrients and salt constituents in the water applied to foliar and soil.
- Irrigation water chemical treatments – acidification, salt additions, wetting agents, etc.
- Soil chemical additions to correct problems associated with irrigation water --- gypsum, lime, fertilizers, etc.
- Leaching programs for salt management.

Fertilization of Sand-Based Greens and Other Sites: #3 Irrigation Water Challenges

Implications:

- Seasonal variability in irrigation water constituents, water/soil amendments, and ET = a dynamic soil/plant nutritional status, both temporally and spatially.
- Soil, water, and tissue testing become more important to monitor "the system". Adopt a proactive and not reactive monitoring/testing approach.
- Future – more concern about fate of constituents in irrigation water on soils, waters, environment.

Fertilization of Sand-Based Greens and Other Sites: #4 Informational Challenges

1. Soil, Water, Tissue Testing.
- Understanding role of each.
- Correct soil test procedures and nutrient rankings.
- Interpretation of results – fertilization is one of the 3 primary management practices on turf. If consultants are used, are their tests and interpretations correct?

Fertilization of Sand-Based Greens and Other Sites: #4 Informational Challenges

2. Foliar Fertilization

Spoon Feeding = light, frequent applications of fertilizer. Excellent practice;
- To enhance nutrient-use efficiency.
- For saline irrigation water and low CEC soils for all nutrients.

But, does:
- Spoon Feeding = Foliar Feeding = Fertigation.
- Foliar Application = Foliar Uptake.

Foliar Feeding

- Defined: Low rate of nutrients applied to the foliage or leaves using < 1-2 gal water per 1000 sq. ft. Nutrients are water soluble and not suspensions.
- Uptake through the cuticle cracks and stomatal pores. Inside the leaves, nutrients pass directly into cells through the cell wall and plasma membrane; or enter the apoplasm (space between cells) and then may be transported in the xylem (up) or phloem (up, downward).

Foliar Applied: Nutrient Mobility

1. Are all nutrients taken up?
- Hot, dry conditions limit uptake.
- Mowing of leaves before uptake—if clippings are returned to the soil, they become available; but not if removed.

2. Are all nutrients translocated downward?
- Mobile---N, P, K, Mg, Cl, Na
- Somewhat Mobile---S, Cu, Mo, Zn, B
- Immobile---Ca, Fe, Mn, Si.

Calcium

With salinity and fluctuating soil chemistry, 'available' Ca becomes the essential management strategy.

Functions:

- Cell membrane stabilization
- Constituent of cell walls
- Carbohydrate translocation
- Protein synthesis
- Activation of enzyme systems
- Enhancement of nutrient uptake in roots

Salinity management involves multi-pronged approach:

**Soil applications to counter excess Na on Soil CEC

**Soil applications for root uptake and reduce Na root toxicity

**Foliar applications for nutritional balance

Ca product release & movement in the soil & plant

Fast Release/Solubility (foliar application for foliar uptake). These are liquids.

**Calcium nitrate – yes
**Calcium chloride - yes
**Calcium gluconate/heptogluconate (? or intermediate)
**Calcium complexed with sugar alcohols (? ")

Intermediate Release/Solubility (foliar application does not mean foliar uptake for suspension products) (root uptake or removal with clippings). **Calcium sulfate (gypsum); Calcium thiosulfate

Slow Release/Solubility (foliar application not foliar uptake for these suspensions) (root uptake or removal with clippings). **Calcium hydroxide / oxide; lime or Dolomite; Calcium carbonate (lime) & powdered coral; Calcium silicate

MANGANESE

FUNCTIONS

- RNA synthesis: chloro-plasts (RNA polymerase)-chlorophyll formation
- Aromatic A.A. synthesis
- Lignin synthesis in roots - (cell wall peroxidase)
- Regulatory auxin level (isoprenoid synthesis-GA)
- Root elongation/lateral root formation
- Salinity tolerance activation in conjunction with Zn
- Take-all disease suppression

- Essential component —2 enzymes: Oxygen evolution in photosynthesis, superoxide dismutase
- Active cofactor in ~35 enzymes: respiratory metabolism of organic acids
- AS SALINITY INCREASES, A KEY MICRONUTRIENT that is often deficient
- Mn foliar program + Mn soil program to suppress take-all.

Fertilization of Sand-Based Greens and Other Sites: #4 Informational Challenges

3. Biostimulants = catch-all term for materials applied to the soil or directly on the plant to provide a "bio-stimulation".
   - Cytokinins (hormone) often give growth stimulation when plant roots are under stress.
   - Insist on full disclosure of the product ingredients --- is the response from N or Fe rather that advertised "active" ingredients.

Fertilization of Sand-Based Greens and Other Sites: #4 Informational Challenges

4. **Basic Agronomics vs. Search for the Silver Bullet products. For maintenance of a good soil/plant nutritional program, the most important aspects are:**
   - **Soil chemical properties are primary – CEC level, nutrient balance, nutrient levels, pH, salt control**
   - **Soil physical problems are also important – especially excessive OM or any factor that limits water movement.**
   - **Soil biological activity or biostimulates--- least important since good turf = good conditions for MO activity.**
   - **Which of these do I emphasize in my programs – time, money, focus?? Use common sense.**

Conclusions

1. **Sand-based greens have always been challenging, but with poorer quality irrigation water + new grasses the challenges have greatly increased.**
2. **Soil and plant nutritional status on such sites is very dynamic and not static.**
3. **Diversity of products (biostimulants) and adoption of foliar feeding have added to the information challenges.**
4. **Follow "common sense" – basics are essential; silver bullets do not work, if it sounds to good to be true-it isn't.**

Resources

USGA Green Section Record Water Series Articles

By R.N. Carrow, R.R. Duncan, and M. Huck.

1. **Understanding water quality guidelines and management of problems arising from poor water quality. 2000. 38(5): 14-24.**
2. **Situations to treat irrigation water. 1999. 37(1): 11-15.**
3. **Use of effluent water for irrigation and potential problems. 2000. 38(2): 15-29.**
4. **Use of seawater or seawater blends for irrigation and potential problems. 2000. 38(1): 15-24.**
5. **Leaching guidelines for *maintenance* and *reclamation* leaching situations. 2000. 38(6): 15-24.**

See www.USGA.org, click on the Green Section Record, and then select the correct issue.

Soil Fertility/Plant Nutrition Resources

- **Turfgrass Soil Fertility and Chemcial Problems: Assessment and Management.** 2002. Carrow, Waddington, Rieke. At—John Wiley and Sons, GCSAA, Amazon, B& N.
- **<www.georgiaturf.com>** Go to: a) 'Fertilization' for soil testing; and b) 'Plant Analysis' for tissue testing.
- **Golf Course Management.** Sept-2003; (1 article); Jan-2004 (2 articles).

Other Trade Publications Resources

1. **R.R. Duncan & R.N. Carrow. 2005. Just a grain of salt. Golfdom 61(7):70-75.**

2. **Periodic articles by Carrow and Duncan in:**
   - **GCM,**
   - **Turfgrass Trends,**
   - **TERO, others**

GCSAA SPONSORED WORKSHOPS

- **BMPs of Water Conservation (Carrow, Duncan, Waltz). 0.5 d**
- **Turfgrass Water Quality: Assessment & Management (Advanced level) (Duncan, Huck). 1.0 d**
- **Salt-Affected Turfgrass Sites: Assessment & Management (Advanced level) (Carrow, Duncan). 2.0 d**
- **Seashore Paspalum Management on Golf Courses (Duncan). 1.0 d**

Book/Other Resources (John Wiley and Sons, Pub.)

- **Carrow and Duncan. Salt Affected Turfgrass Sites: Assessment & Management (1998).**
- **R.N. Carrow, D.V. Waddington, & P.E. Rieke. Turfgrass Soil Fertility & Chemical Problems: Assessment & Management (2002)**
- **Duncan and Carrow. Seashore Paspalum: The Environmental Turfgrass. (2001)**
- **Duncan, Carrow, Huck. Turfgrass Water Quality: Assessment & Management (2006).**