

**Restoring Performance:
Getting at the ROOT
of the Problem**

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Sports Field Playability

- Fields often blamed first for poor athletic performances
- Inputs for management are insufficient and usually an afterthought



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Extensive, healthy roots are essential for field performance and ecosystem function



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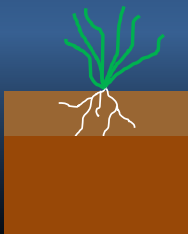
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Reasons for Poor Rooting

- Soil compaction
- Excessive soil moisture
- Too much nitrogen fertility
- Low light conditions
- Excessive thatch
- Etc.



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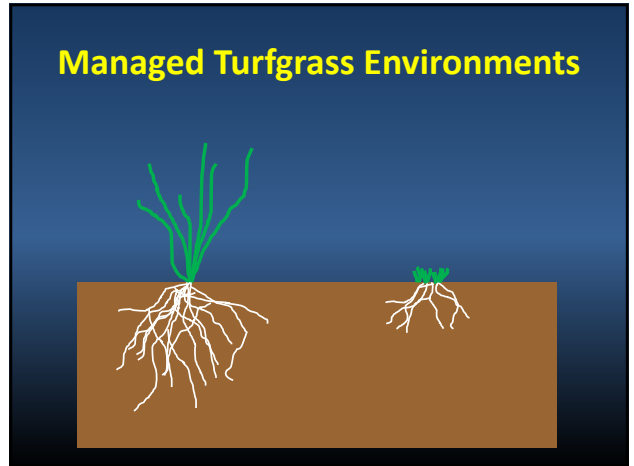
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Managed Turfgrass Environments

- Mowing is always a stress
 - Causes a reduction of roots
 - Reduces carbohydrate production and storage
 - Increases disease susceptibility
 - Decreases plant and microbe interactions
 - Requires more management inputs

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Managed Turfgrass Environments

Reduced roots
=
Reduced leachates
=
Less microbes

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Managed Turfgrass Environments

Less microbes
=
Reduced OM
degradation &
nutrient mineralization

Less microbes
=
Less defense against
pathogens

Mineralization = conversion of nutrients from organic to inorganic forms that are plant available.

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Managed Turfgrass Environments

Less microbes
=
Reduced OM
degradation &
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Less microbes
=
Less defense against
pathogens

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Managed Turfgrass Environments

- Less microbial activity and diversity
 - Thatch accumulation
 - Increased need for fertilizers
 - Increased need for fungicides for disease control

**THE VITAL ROLE OF
MICROBES**

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Bio-Nutrition

- Revitalize the Soil
- Repopulate the rootzone with microbes
- Apply appropriate nutrition
- Connect the Soil with the turfgrass

**Bio
NUTRITION**

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Simple Concept

Difficult Solution

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The "Real" Turfgrass Environment

- Perennial system
- Continuous mowing – species specific
- High expectations
- Always changing – microclimates
- Cultural practices impact the system
 - Not always under our control

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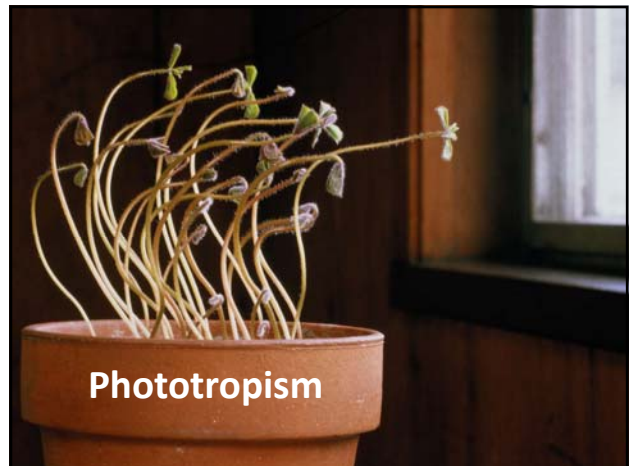


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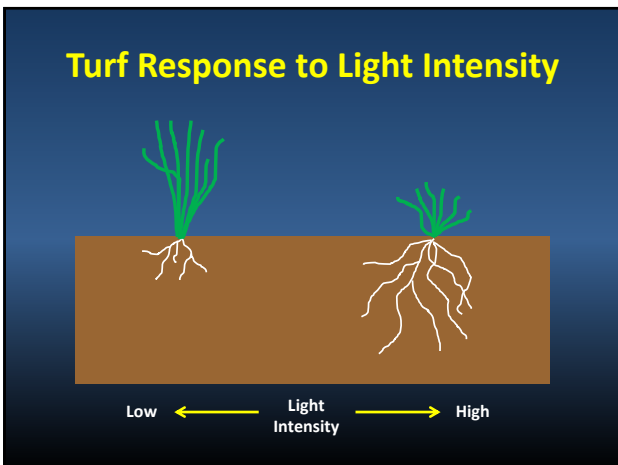
Turf Response to Light Intensity

- High light intensity:
 - Horizontal orientation of leaf blades
- Extreme low to no light intensity:
 - Failure of the turf to survive
- Moderate shade:
 - Leaf blades assume a more upright orientation – “reaching” for light

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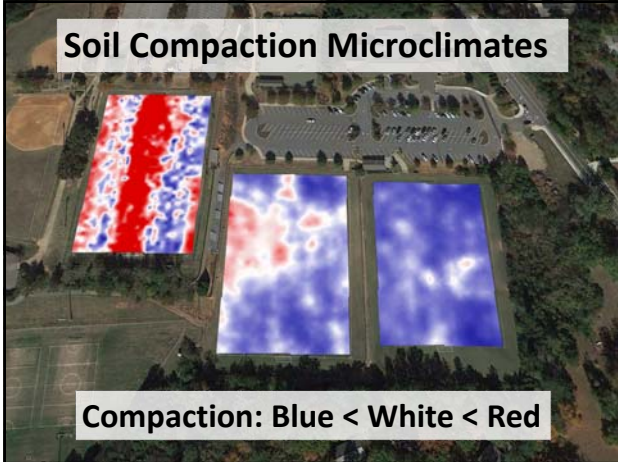
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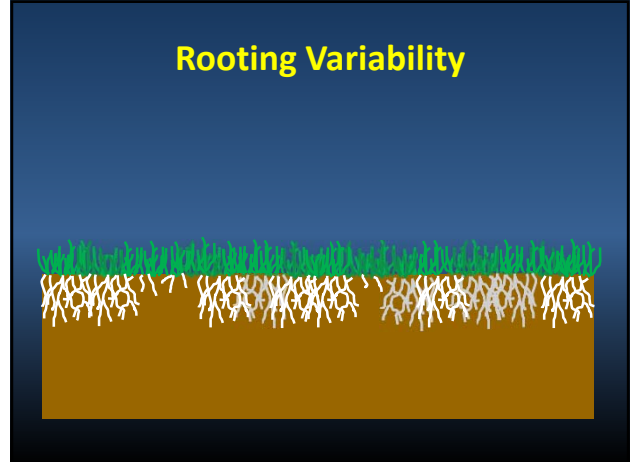
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Revitalize the Soil Step 1

- **Continuous use of fertilizers and pesticides can alter the turfgrass rootzone**
 - Overuse of fertilizers without knowing nutrient status
 - Use of fertilizers with high salt index
 - All pesticide applications can negatively affect soil microorganisms

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Soil Testing

- **Purpose:**
 - Measure plant-available soil nutrient status
 - Form fertility recommendations
 - ID potential antagonists or toxicities

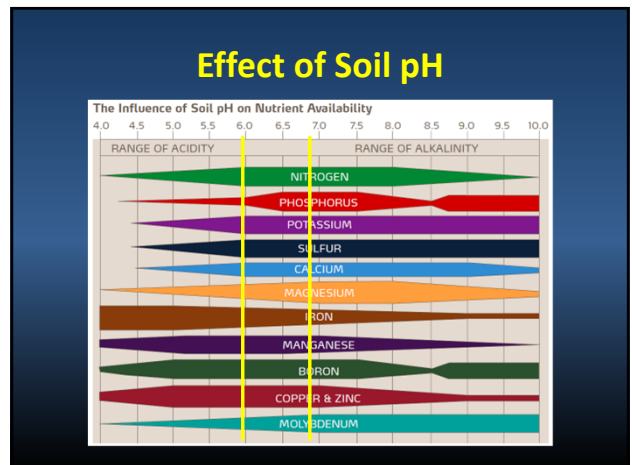


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Nutrients in the Soil

- **Nutrients exist in numerous forms**
 - Nutrient pools
- **Soluble to insoluble forms**
 - Soluble = readily available in the soil solution
 - Weakly bound = adsorbed, easily exchangeable, but available
 - Strongly bound = insoluble


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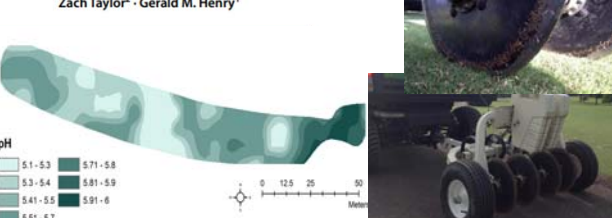
Precision Agriculture (2019) 20:496–519
<https://doi.org/10.1007/s11119-018-9593-2>

Soil pH Variability



Predicting spatial structure of soil physical and chemical properties of golf course fairways using an apparent electrical conductivity sensor


Rebecca A. Grubbs¹ · Chase M. Straw¹ · William J. Bowling¹ · David E. Radcliffe¹ · Zach Taylor² · Gerald M. Henry¹



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Rhizosphere

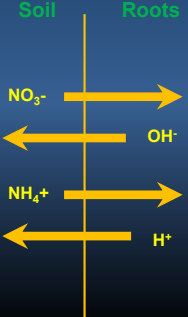
- Narrow region of soil influenced by roots and soil microorganisms
- Can play a critical role in nutrient availability and uptake



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N Source Influences Soil pH

- Calcium nitrate increases pH, whereas ammonium sulfate reduces it
- When roots absorb a nitrate ion (NO_3^-), a hydroxyl ion (OH^-) is released, increasing rhizosphere pH
- When roots absorb an ammonium ion (NH_4^+), a hydrogen ion (H^+) is released, reducing rhizosphere pH
- Sulfate (SO_4) and calcium (Ca^+) have little to no effect on soil pH



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High Salt Index Fertilizers

- Increase salinity level of soil
- May require flushing of salts from the soil
 - Na:Ca index > 5
- Methods:
 - Deep irrigation cycle ≥ 1.5 inches
 - Flush programs
 - Humic/Fulvic material
 - Soluble calcium product
 - Wetting agent/soil penetrant

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Encourage Microbial Activity

- Fungicides/Herbicides
 - Some control beneficial fungi that help with nutrient availability
 - Utilize cultural methods to reduce pests prior to use




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Repopulate with Microbes

Step 2

- Stimulate local populations
- Apply microbial inoculants

This is where biostimulants fit into your management program!!



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Biostimulants

- **Biostimulants** are substances or microorganisms that stimulate existing biological and chemical processes in plants and/or associated microbes
- Biostimulants do not contain many nutrients

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Biostimulants

Four major categories

1. Microbial inoculants
 - Free-living fungi
 - Arbuscular mycorrhizal fungi (AMF)
 - Free-living bacteria
2. Protein hydrolysates and amino acids
3. Humic Substances
 - Humic acids
 - Fulvic acids
4. Seaweed extracts



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Biostimulants

Potential Benefits

- Enhance turfgrass growth and/or quality by improving nutrient uptake, nutrient use efficiency and/or tolerance to abiotic stress (ex. heat, drought, saline soils)



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Stimulate Local Microbe Populations

- Improve their food source
- Stabilize their environment



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Microbial Inoculants

- Bacteria and fungi
- Aid in nutrient mineralization and pest control
- Applied as seed treatments or liquid applications



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Microbial Inoculants

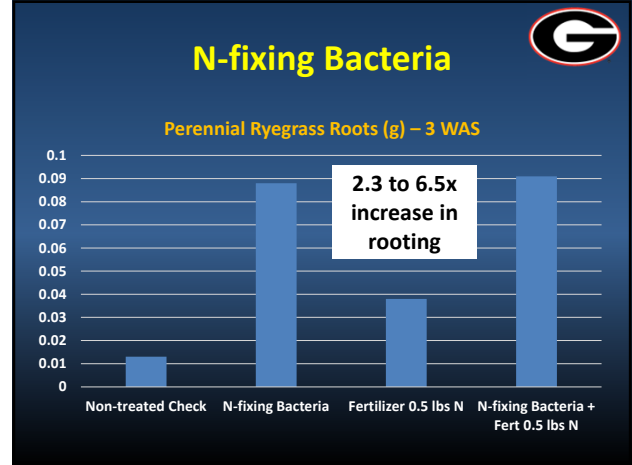
- The key is **consistency**
- Large seed and chemical companies have recently purchased several microbial firms
- More money has gone into research and development – production of better products



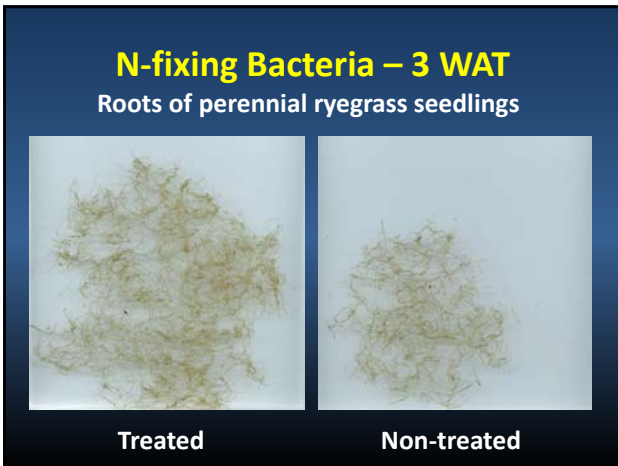
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 DOI: 10.1002/ajb.21930

Crop, Forage & Turfgrass Management

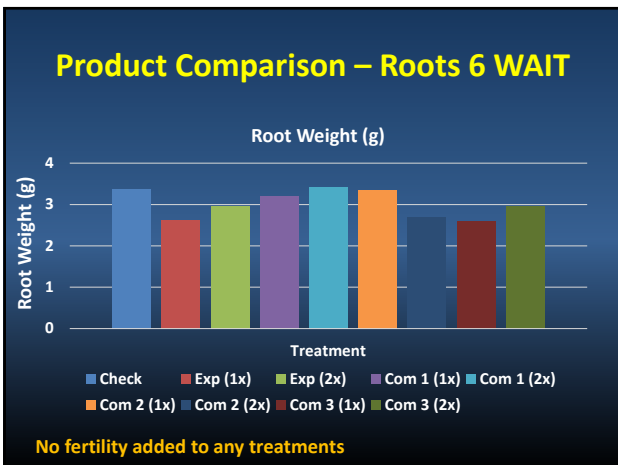
RESEARCH
 Applied Turfgrass Science

The impact of commercially available microbial inoculants on bermudagrass establishment, aesthetics, and function

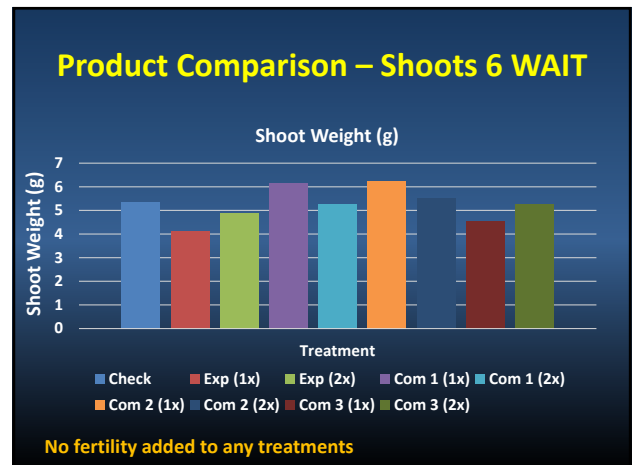
Connor Bolton¹ | Miguel L. Cabrera¹ | Mussie Habteselassie² | Daniel Poston³ | Gerald Matthew Henry⁴

- Seeded 'Sahara II' common bermudagrass
- Treatments: 3 commercially available and 1 experimental bacterial inoculant
- Some treatments received a sequential application 4 WAIT
- High carrier volumes (80 to 320 GPA)

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Microbial Inoculants

- Minimal regulations
- No guarantees
- Hard to survive under adverse weather
 - Activity decreases as soil temperature reach 81 F
 - Can be worse in dry soils
- Antagonism from existing soil microbes
 - Promote tissue dwelling microbes
- Mixing and application can be messy
- Most success with cool-season grasses and in the greenhouse
- Best success with on site activated products

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Biostimulant Effect on Rooting and Soil Compaction

- **Trial site:** Athletic field on native clay loam soil
- **Turfgrass species:** 'Tifway 419' hybrid bermudagrass
- **Treatments:**
 - Urea 46-0-0 fertilizer
 - Sea3 soil conditioner
 - Humic acid, molasses, and kelp
 - Claims to feed and proliferate microorganisms so they release unavailable nutrients and improve compacted soils



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Humic Substances

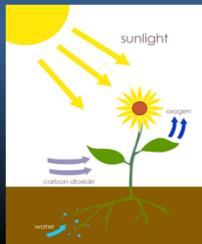
- Humic and fulvic acids
- A natural source of rooting hormone
- Derived from the decomposition of plants and animals
- Comprise 60 to 80% of organic matter
- Most resistant component of OM to microbial decomposition
- Sources: mined soft coal, peat, compost

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Humic Substances

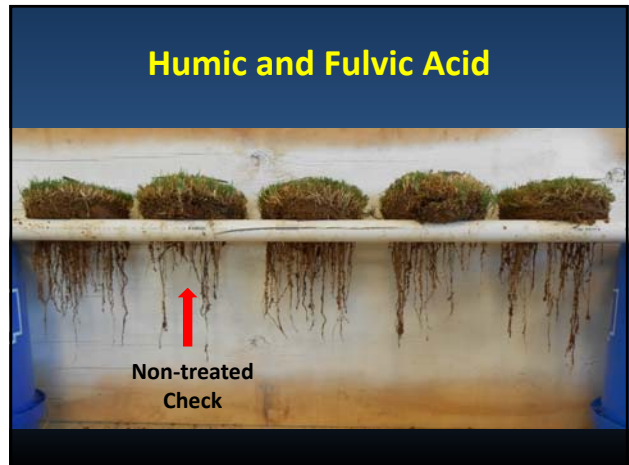
Potential Benefits

- Increase photosynthesis and root growth



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Humic and Fulvic Acid



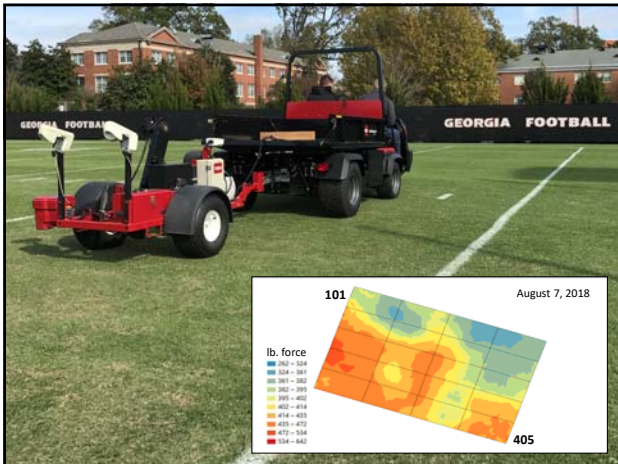
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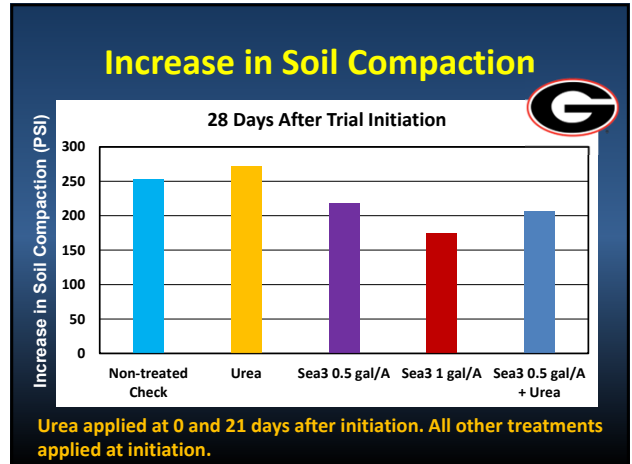
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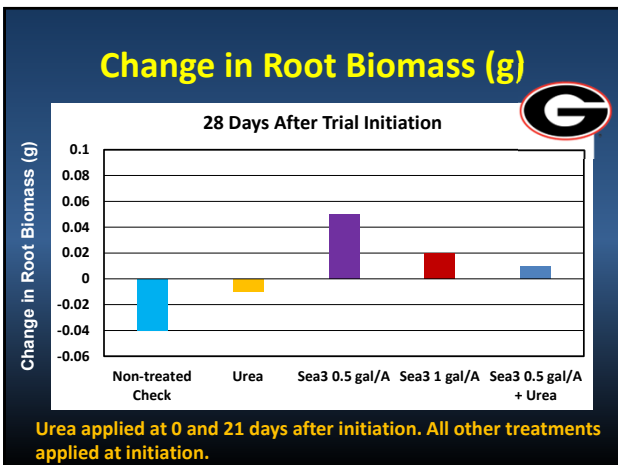
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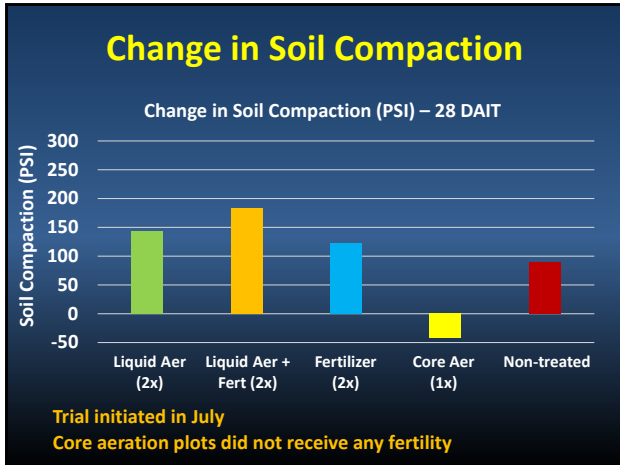


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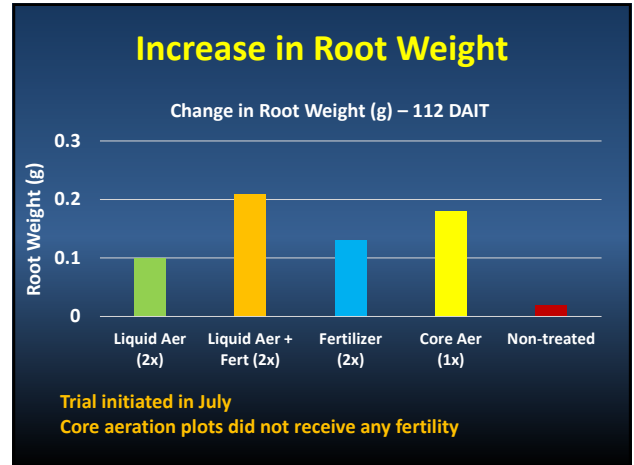
Liquid Aeration Products

- Contain humic and/or fulvic acid
- Some contain beneficial microorganisms and/or essential nutrients
- Claims: "Forget messy aerator lawn plugs with core aeration or lawn aerator shoes! Our safe, innovative formula is created to effectively loosen and soften compacted soil. When you enhance your lawns soil structure, you detoxify soil and improve overall root growth by decreasing compaction."

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Published December 28, 2016

Long-term Effect of Open-Spoon Aerification on Plant and Soil Properties of Community Level Sports Fields

Chase M. Straw,* Rebecca A. Grubbs, Gerald M. Henry, Robert N. Carrow, and Van Cline

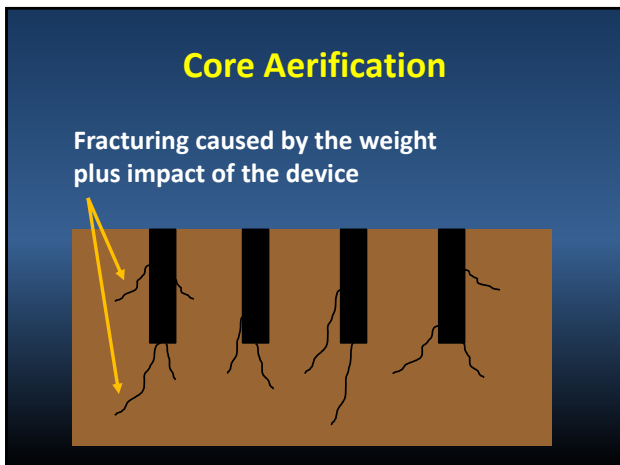
Applied Turfgrass Science
ACCEPTED

Core Ideas

- In 2013, 47% of sports turf managers reported using open-spoon aerification.
- Long-term effect of open-spoon aerification was minimal on measured properties.
- It is recommended that sports turf managers

- STMA survey (2013) – 47% reported using OS aerification
- Aerification events – 0, 1, 2, 3, or 4 times/year – 2 year study

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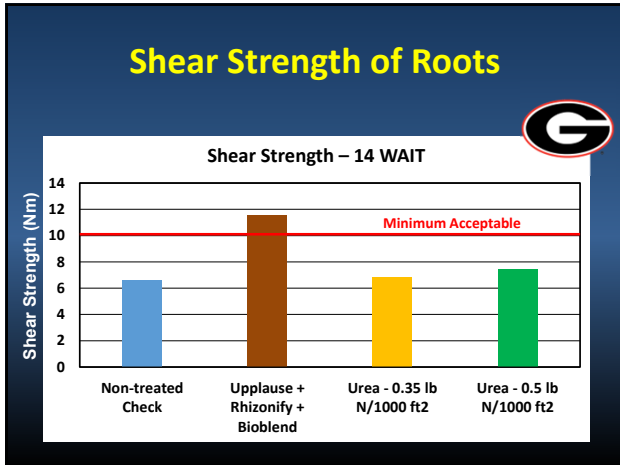
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Biostimulant Effect on Rooting and Soil Compaction

- Trial site: Athletic field on native clay loam soil
- Turfgrass species: 'Tifway 419' hybrid bermudagrass
- Treatments:
 - Urea 46-0-0 fertilizer
 - Upplause + Rhizonify + Bioblend
 - Ammoniacal, nitrate, and urea nitrogen; phosphate, potash, iron, manganese, zinc, calcium, and wetting agent

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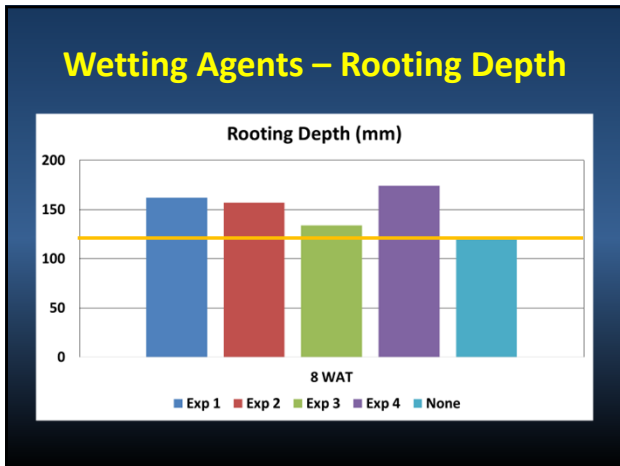
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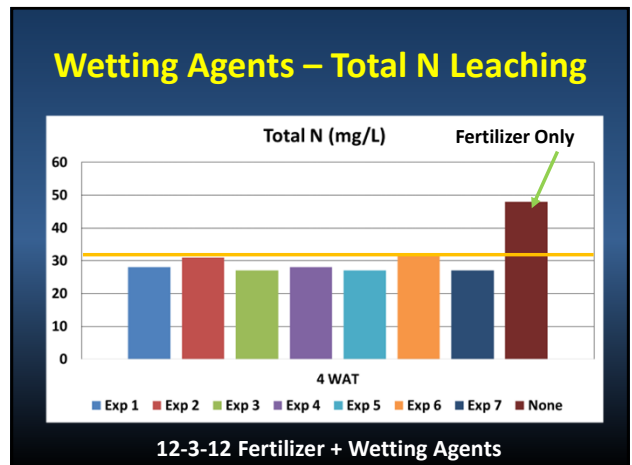
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- ### Wetting Agents
- Increase the uniformity of soil moisture throughout the soil profile
 - Retain soil moisture deeper in the soil profile
 - **Decrease fertility leaching which may increase length of availability**

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New PGR Technology (GlucoPro)

- **Methyl-alpha-D-mannopyranoside**
- Unlocks and releases glucose bound to Lectin proteins that are found in high concentrations in plant roots
- Release of glucose provides a flush of energy for various biological functions

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Root Growth – 3 MAIT

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Apply Appropriate Nutrition

- Apply fertility only after a soil test is conducted and a need is determined
- Use “biorational” fertilizers
 - Not synonymous with organic
 - Synergistic with beneficial organisms
 - Feed and/or not kill microbes that in turn enhance turfgrass growth

Step 3

This is where **biofertilizers** fit into your management program!!

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Biofertilizers

- Anything made from previously living plants or animals
- Can be grouped by how much they are processed or decomposed
- Ex.
 - Slurry and farm yard manure
 - Compost
 - Biodigestate

Biodigestate = material that remains after anaerobic digestion of a biodegradable feedstock.

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Biofertilizers

Potential Benefits

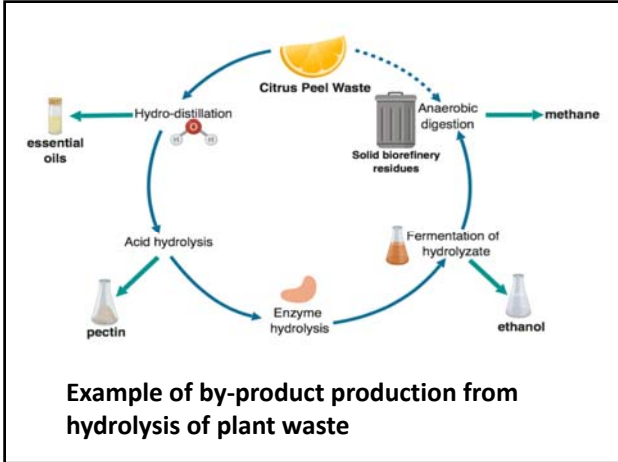
- Supply nutrients (ex. nitrogen, phosphorus, potassium, calcium, etc.) in forms that are directly absorbed by plants, or quickly decomposed to available forms, to cause an increase in turfgrass growth and/or quality

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Anaerobic Digestion

- Biofertilizers are produced through the process of anaerobic digestion

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Connect the Soil with the Plant

Step 4

- Environmental stress disrupts plant metabolism
- This weakens plant growth and reduces root exudates – essential for microbial activity
- **Biostimulants** are often utilized to combat these issues

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Protein Hydrolysates and Amino Acids

Potential Benefits

- Stimulation of plant microbiomes
 - Substrates such as amino acids could provide a food source for plant-associated microbes that help turfgrass acquire nutrients and water and withstand biotic and abiotic stress

Hydrolysis = chemical breakdown of a compound due to reaction with water

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Be Your Own Scientist

- You should test products out at your facility
 - Under your management practices
 - Within your climate and environment
- Locate a small test area with similar characteristics as the areas you want to use the products on in the future
- One demo plot is not enough – replication is needed!!!

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Questions?

TEAM UGA

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