What do we want to learn today?

The My organic matter journey……

- USGA/EIFG Greens Study (9 years).
- People a lot brighter than me
  - “Talking Turf” GCSAA conversation.
  - Paul Rieke, USGA visit
  - Conversation with Paul Vermeulen, Director, Competitions Agronomy at PGA TOUR, former USGA Agronomist.
- Great funding/time support from USGA (initially), NE-GCSA, GCSA of SD, Peaks and Prairies GCSA, industry and a slew of GC supers.
- Road Show.
Organic matter development: *Are We the Problem?*

Or:

is organic matter % the green speed of the new millennium?

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**ASA Monograph (3RD Edition)**

**Chapter 12**

*Characterization, Development, and Management of Organic Matter in Turfgrass Systems*

R.E. Gaussoin, Dep. of Agronomy and Horticulture, Univ. of Nebraska

W.L. Berndt, Dep. of Resort and Hospitality Management, Florida Gulf Coast University

C.A. Dockrell, Teagasc College of Amenity Horticulture, Dublin, Ireland

R.A. Drijber, Dep. of Agronomy and Horticulture, Univ. of Nebraska

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How does organic matter accumulate?

- Organic matter; defined
  - dead or near dead plant residue which accumulates in the grass ecosystem

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How does organic matter accumulate?

- As grasses mature there is a continual senescence of non or limited function parts (roots, shoots and leaves)
- Senescence also happens when damage or injury occurs
How much OM is produced annually?

- Roots = 3500 lbs/acre
- Leaves = 2000 lbs/acre
- Other = 2500 lbs/acre
- TOTAL = 8000 lbs/acre 8967 kg/ha

Fairway height blue/rye estimated annual production

Factors influencing rootzone (P)OM accumulation

- Mowing
  - increase height= increase rooting
- Irrigation
  - root growth restricted in waterlogged soils
- Cultivation
  - increase or decrease
- Fertility
  - increase or decrease
- Stress

Where does organic matter accumulate?

- Above ground
  - Thatch/Mat
  - clipping residue
    - relatively short term
    - “pseudo” thatch

- Below ground
  - rootzone
  - rhizosphere

Importance of (P)OM in the rhizosphere

- deposition of particulate OM
- microbial niches
- nutrient uptake
- pathogen competition
Rootzone accumulation yearly in sand green

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.65%</td>
<td>6.0%</td>
<td>3.0%</td>
</tr>
</tbody>
</table>

USGA spec. green constructed with 20% (by volume) organic matter

Green Age Effects on Microbial Biomass

<table>
<thead>
<tr>
<th>Age of Green (yrs)</th>
<th>3</th>
<th>8</th>
<th>14</th>
<th>28</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microbial Biomass</td>
<td>3</td>
<td>8</td>
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</table>

Green Age Effects on Microbial Stability

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<th>8</th>
<th>14</th>
<th>28</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microbial Stability</td>
<td>3</td>
<td>8</td>
<td>14</td>
<td>28</td>
</tr>
</tbody>
</table>

Thatch

A loose, intermingled, organic, layer of dead and living shoots, stems, and roots that develops between the zone of green vegetation and the soil.
Benefits of “Moderate” Thatch

- Improved resilience and cushion
- Improved wear tolerance
- Insulate soil/crown to temperature extremes

Greens Height Bentgrass Thatch Thickness (mm)

Problems with excessive thatch
- Footprinting

Fairway Height Bentgrass Thatch Thickness (mm)

Problems with excessive thatch
- Scalping
Problems with excessive thatch

- LDS

Doug Soldat’s work at UW

- Next 3 slides
- Wetting agents, year differences and low and high OM greens

2009 – Wet Year – Low Organic Matter Putting Green

2010 – Wet Year – Low Organic Matter Putting Green

2010 – Wet Year – High Organic Matter Putting Green

Problems with excessive thatch

- Reduced Stress Tolerance
Problems with excessive thatch

- Overseeding Failure

Mat

Thatch that has been intermixed with mineral (soil) matter

Because of inherent ambiguity in terminology and sampling techniques, the term “thatch-mat” has appeared frequently since the late 2000’s (McCarty et al., 2007; Barton et al., 2009; Fu et al., 2009).

and yet one more definition

SOM- Soil Organic Matter

Physical And Chemical Characteristics Of Aging Golf Greens

Roch Gaussoin, PhD
Jason Lewis
Ty McClellan
Chas Schmid
Bob Shearman, PhD

Because of inherent ambiguity in terminology and sampling techniques, the term “thatch-mat” has appeared frequently since the late 2000’s (McCarty et al., 2007; Barton et al., 2009; Fu et al., 2009).
Treatments

- rootzone Mix
  - 80:20 (sand/peat)
  - 80:15:5 (sand/peat/soil)
- Grow-In Procedure
  - Accelerated
  - Controlled

Project Schedule (Phase I)

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<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Greens construction (one set per year)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seeding</td>
<td></td>
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</tr>
</tbody>
</table>

Data collection on soil physical, chemical, and microbial characteristics influenced by rootzone materials and grow-in procedures.

USGA Specification Green

Project Schedule (Phase II)

| 2002 | 2003 | 2004 | 2005 |

Data collection on soil physical and chemical characteristics as influenced by age, rootzone materials and grow-in procedures.
Materials and Methods

<table>
<thead>
<tr>
<th>Age</th>
<th>Condition</th>
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</thead>
<tbody>
<tr>
<td>9 yr old</td>
<td>green</td>
</tr>
<tr>
<td>10 yr old</td>
<td>green</td>
</tr>
<tr>
<td>12 yr old</td>
<td>green</td>
</tr>
<tr>
<td>13 yr old</td>
<td>green</td>
</tr>
</tbody>
</table>

As of 2009

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Formation of Mat

- Formation of mat layer increased approximately 0.65 cm annually (following establishment year).
- No visible layering, only a transition is evident between mat and original rootzone.
- Topdressing program
  - Light, Frequent
    - every 10-14 days (depending on growth) and combined with verticutting
  - Heavy, Infrequent
    - 2x annually (spring/fall) and combined with core aerification

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Significant decrease in macro-porosity over time

Significant increase in micro-porosity over time

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No significant change in total porosity over time
Materials and Methods

- 2004 rootzone samples taken below mat layer from each soil treatment and sent to Hummel labs for Quality Control Test (24 total samples) & tested against original quality control test (z-score).
- Other analysis also completed

Change in Rootzone Particle Size Distribution

- All rootzones tested in 2004 showed increased proportion of fine sand (0.15 - 0.25 mm) with decreased proportion of gravel (> 2.0 mm) and very coarse sand (2.0 - 1.0 mm).
- 5 of 8 rootzones were significant (z-score) for increased fine sand content.

Conclusions

- The $K_{SAT}$ decrease over time may be due to organic matter accumulation above and in the original rootzone and/or the increased fine sand content originating from topdressing sand
Root Zone: Mat vs. Original

- **pH:**
  - Mat < Original for all USGA and California Greens.
- **CEC, OM, and all Nutrients tested:**
  - Mat > Original for all USGA and California Greens.

Want to know more?


Why is high OM considered to be “bad”?

- Loss of infiltration
- Decreased aeration
- Traps “toxic” gases
- Are these concerns real or imagined?
- Why the confusion?

Organic Matter Recommendations

- **Range**
  - 1.5 – 2.5% between 0.25 to 1-inches
  - 8 – 15%
- **Recommendations for almost every point in between**
Sampling of Recommendations

Private Lab B: < 3% - unrealistic
< 4% - difficult
< 5% - realistic & achievable

Low: < 3 – 4%

Hartwiger & O'Brien: < 3.5 – 4.5%

Private Lab A: 1.5 – 2.5% at a 0.25 to 1-in depth

Carrow: < 3%
McCoy: < 3.5%
Adams: < 5%
J. W. Murphy: < 4.5%

There is no “magic” number

Analysis Methods

- Many exist, but the most relevant is “combustion” or “loss on ignition”
- The sample represents both dead and living organic matter
  – Food for thought……

“the squeeze test”
(courtesy of Dave Oatis, Former USGA Director NE-US)

Organic Matter Sampling Protocols

1. thatch + mat layer
2. between 0.5” and 4.5”
3. between 0 and 35 cm
4. between 0 and 25 cm
OM Testing

- Know how your sample was taken and compare notes with others that use the same protocol
- Take annual tests to determine long-term trend
  - Same time of year
  - Same location and green
- Correlate your test results with turf quality and performance during stressful environmental conditions to determine need for changes in management program
- Threshold/critical levels likely vary across the United States and from course to course

How do you get rid of OM?

- Decomposition (microbial)
  - Increase surface area and aeration
  - Inoculation (???)
- Removal
  - Power raking, verticutting, dethatching, core aerification
- Dilution
  - Topdressing

Seasonal Variation
(One Location)

Organic Matter Degradation Study

Treatments

- Aerator (Granular)
- Aerator (Liquid)
- EXP072
- EXP074
- EXP076
- Carbo-Plex
- Bio-Blend
- Carbo-Plex + Bio-Blend
- Bio-Groundskeeper (Granular)
- Bio-Groundskeeper (Liquid)
- Thatch X
- EXPO70M
- EcoChem Lawn Thatch Reducer
- Untreated Control
Locations

- **KY Bluegrass Tee Box**
  - Native Soil
- **Bentgrass Green**
  - California Green
- **KY Bluegrass Sports Turf**
  - Sand based
  - 2.5” Mowing

Data Collection

- Infiltration
- Penetrometer
- Thatch
- Organic Matter
  - Thatch, 0-3”, 3-6”

Plot Set-Up

14 Treatments, 3 Reps

Analysis Summary

<table>
<thead>
<tr>
<th>Source</th>
<th>Thatch (mm)</th>
<th>Clegg (g)</th>
<th>Infiltrat (in/hr)</th>
<th>Thatch (OM %)</th>
<th>0-3” (OM %)</th>
<th>3-6” (OM %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site</td>
<td>**</td>
<td>*</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Trtmnt</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Site X Trtmnt</td>
<td>NS</td>
<td>(0.10)</td>
<td>NS</td>
<td>NS</td>
<td>*</td>
<td>NS</td>
</tr>
</tbody>
</table>

Each Plot Aerified before Application of products

0-3” OM %

![Graph showing 0-3” OM % for Sports Turf, Green, and Fairway]
Summary

- No product increased degradation of OM

How effective is removal?

- Surface disruptive, short and long term
- Core aeration is the most widespread practice recommended for OM management

<table>
<thead>
<tr>
<th>Tine Size (in.)</th>
<th>Spacing (in.)</th>
<th>Holes/ft²</th>
<th>Surface Area of One Tine</th>
<th>Percent Surface Area Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4</td>
<td>1.25²</td>
<td>100</td>
<td>0.049</td>
<td>3.4%</td>
</tr>
<tr>
<td>1/4</td>
<td>2.5²</td>
<td>25</td>
<td>0.049</td>
<td>0.9%</td>
</tr>
<tr>
<td>1/2</td>
<td>1.25²</td>
<td>100</td>
<td>0.196</td>
<td><strong>13.6%</strong></td>
</tr>
<tr>
<td>1/2</td>
<td>2.5²</td>
<td>25</td>
<td>0.196</td>
<td>3.4%</td>
</tr>
<tr>
<td>5/8</td>
<td>2.5²</td>
<td>25</td>
<td>3.07</td>
<td>5.3%</td>
</tr>
</tbody>
</table>
Organic Matter Management

- Funded by:
  - USGA (2006)
  - Nebraska Golf Course Superintendents Assoc. (2007-2009)
  - Golf Course Superintendents Assoc. of South Dakota (2006-2009)
  - Peaks & Prairies GCSA (2007-2009)

Project Objective

- National Survey
  - Determine cause and effect relationship among maintenance practices and their interactions relative to surface OM accumulation

Sampling Procedures

**Years 1, 2, & 3**
- At least 3 different greens per golf course sampled
- Soil samples taken from 3 different area per green
- Samples are evaluated for OM levels using LOI
- GPS location

**Management & Site survey**

Sampling Methods

- Samples from at least 3 greens per course
  - (1) Problematic, (1) Non-problematic plus rebuilt or varied age/management
- 3 samples from each green
- Samples taken with ¾ inch soil probe
2006/07/08 Samples

- Sixteen states
- 117 golf courses sampled
  - More than 1600 samples

Problematic vs Non-problematic

Superintendent predicted vs actual

Green Age

Is the age effect misleading?

- Sampling issue:
  - Mat depth increases as green ages resulting in more OM in the same volume soil.
**Organic Matter in USGA Specification Rootzones**

- Thatch
- 0-2.5cm
- 2.5-10cm
- 10-20cm

LSD=0.05

**Cultivar**

**Mat Development with Age**

- Green Age (years)
- NS
- **NS**
- 8 7 6 5

**Cultivar**

**State Differences** (highly correlated with age)

**Cultivation Frequency (& type)**
Survey Summary

- None of the variables collected, by themselves, or in combination with others, predicted OM.
- Courses using >18 cubic ft/M of topdressing with or without “venting” consistently had the lowest OM.
- Of the known cultivars, no differences in OM were evident.

*1 ft³ = 100 lbs of dry sand; yd³ = 2700 lbs

Onsite NTEP Cultivar Evaluation

1. L-93  16. SR 1820
2. Putter  11. SR 1119
3. Cato  12. Viper
5. LCB-103  14. Imperial
6. Penncross  15. Penn A-1
8. TrueLine  17. Penn G-6
New ultra-dense varieties of bentgrass and bermudagrass are especially susceptible to excessive organic matter accumulation due to high shoot density and the ability to grow a deep, dense root system in sand-based rootzone material. Working topdressing into a tight canopy of turf is a challenge, and much of the sand can be removed with the clippings.”

Vavrek, 2006

Topdressing and the new bents

Easy or hard???

New bents = denser and more upright
Pulling cores or poking holes?

- In 2005, 45 of 141 courses surveyed* planned no core removal
  - Many had not pulled cores for 2-20 years
- 75 planned to pull cores
  - 35 of the 75 had no agronomic reason to pull a core (based on USGA Agronomist evaluation) while 40 "needed" to pull cores
- With current and evolving cultivation/topdressing/rootzone technologies is pulling a core always necessary?
- Finally, is core cultivation an effective way to manage OM?

* Mid-continent region USGA

Let’s take a quick look at that…

- Study initiated 22 June 2005; concluded 11 Nov. 2005
- 2 USGA Putting Greens
  - Constructed in 1997 and 2000
- Sample every 2 weeks for 20 weeks
- 2 depths of interest
  - 3 & 6"

<table>
<thead>
<tr>
<th>Time after core creation (weeks)</th>
<th>2</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>14</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Putting Green Depth</td>
<td>Organic Matter Reduction (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 yr</td>
<td>3&quot;</td>
<td>78</td>
<td>73</td>
<td>70</td>
<td>71</td>
<td>69</td>
<td>66</td>
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<td></td>
<td>6&quot;</td>
<td>71</td>
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<td>59</td>
<td>56</td>
<td>57</td>
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<tr>
<td>5 yr</td>
<td>3&quot;</td>
<td>73</td>
<td>66</td>
<td>61</td>
<td>62</td>
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<td>51</td>
<td>52</td>
<td>52</td>
<td>51</td>
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</tbody>
</table>
Organic Matter Management Study

Objectives
1. Determine if conventional hollow tine is more effective than solid tine aerification at managing organic matter accumulation
2. Determine if venting (less invasive cultivation) methods are effective at managing OM accumulation

Treatments

<table>
<thead>
<tr>
<th>Tine Treatment</th>
<th>Venting Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>2X Hollow tine</td>
<td>PlanetAir</td>
</tr>
<tr>
<td>2x Solid tine</td>
<td>Hydroject</td>
</tr>
<tr>
<td></td>
<td>Bayonet tine</td>
</tr>
<tr>
<td></td>
<td>Needle tine</td>
</tr>
</tbody>
</table>

All treatments received the same topdressing quantity (22 ft³/M) but different frequency

Regional Survey

- Annual topdressing rate for 10 well maintained courses in each region
  - Stable maintenance program during past 5 growing seasons
  - Same general turf conditions
- Surveys are not research!
  - Fertility
  - Traffic
  - Green construction
  - Etc.
Survey Anticipated Results

- Cool-season - gradual increase in annual topdressing rate from north to south and east to west corresponding to length of growing season
- Warm-season - changes in annual topdressing rate corresponding to overseeding practices, length of growing season, annual rainfall
- Surveys are not research!
  - fertility
  - traffic
  - green construction
  - etc.

Survey Review

- Regional differences were found, however not exactly as predicted
- Some differences did not appear to have a basis in agronomy or climatic conditions
- Survey results generate multiple questions regarding current industry practices and suggest need to conduct further research in the area of organic matter management
- It is premature to conclude that the survey provides guidance for establishing sound topdressing recommendations due to the broad range of the data and the very high standard deviation found in most regions

Materials and Methods

- Green Age:
  - 12 years
  - 9 years
- Data collected:
  - OM% (pre-cultivation/monthly)
  - Single wall infiltration (monthly)

Infiltration (in/hr)

<table>
<thead>
<tr>
<th>0</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
</tr>
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<tbody>
<tr>
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<td>NONE</td>
<td>SOLID</td>
<td></td>
<td></td>
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<tr>
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<td>B</td>
<td>B</td>
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</tbody>
</table>

Relationship between OM and Infiltration

<table>
<thead>
<tr>
<th>Infiltration (in/hr)</th>
<th>OM %</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3.5</td>
</tr>
<tr>
<td>10</td>
<td>3.0</td>
</tr>
<tr>
<td>20</td>
<td>2.5</td>
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<tr>
<td>30</td>
<td>2.0</td>
</tr>
<tr>
<td>40</td>
<td>1.5</td>
</tr>
<tr>
<td>50</td>
<td>1.0</td>
</tr>
</tbody>
</table>

*Significant at α = 0.01

All treatments received the same topdressing quantity (22 ft³/M) but different frequency

Equilibrated to identify differences of the practices in question
OM Data Analysis Year 1
- No differences between green age except for higher % in older green
- No differences among venting methods

OM Data Analysis Year 2
- No differences between green age except for higher % in older green
- No differences among venting methods

Effect of Aerification on OM

2.1
2.2
2.3
2.4
2.5

None Core Solid
OM Data Analysis Year 2

- No differences between green age except for higher % in older green
- No differences among venting methods
- No interactions with solid/hollow/none

What these data do/don’t suggest

- Topdressing is the most consistent and repeatable factor in OM management
- Cultivation was insignificant as a means to control OM
- However, a superintendent must use whatever tools they have at their disposal to insure sand is making it into the profile and not the mower buckets

OM Data Analysis Year 2

- No differences between green age except for higher % in older green
- No differences among venting methods
- No interactions with solid/hollow/none
- No differences among solid/hollow/none

Topdressing interval relative to tine/vent combinations (22 cu ft/M)*

- NONE/NONE – 5-10 days
- Solid & Hollow/NONE – 7-14 days
- Solid & Hollow/LIC – 14-18 days

*Observed and calculated based on displacement and surface area opened
GreenKeeper Survey

**cool season only, mark all that apply**

In the last 5-10 years, on our greens, our facility has:

- Increased topdressing quantity.
- Increased topdressing frequency.
- Increased hollow (equal or greater than 0.5") tine aeration.
- Increased solid tine (equal or greater than 0.5") aeration.
- Decreased hollow (equal or greater than 0.5") tine aeration.
- Decreased solid tine (equal or greater than 0.5") aeration.
- Made minimal changes in topdressing application quantity/frequency.
- Made minimal changes in cultivation practices.
- Increased "venting" practices.

---

Survey Respondents via Greenkeeper

“Advocates of solid-tine aeration report that they get the same benefits of thatch and organic matter reduction with less labor for the collection and removal of aeration cores. Whether you pull a core or use solid tines, it’s all about sand volume and the ability to dilute organic matter in the rootzone. Regardless of the method, the most important factor is filling the hole with sand. It’s all about dilution, and if you can do that with less of a mess and less labor, then solid-tine aeration is a viable alternative.”

---

303 Responses

“the solution to pollution is dilution”
Topdressing

Old Tom Morris (1821–1908) is thought to have discovered the benefits of topdressing accidentally when he spilled a wheelbarrow of sand on a putting green and noted how the turf thrived shortly afterward (Hurdzan, 2004).

J.B. Beard is his classic textbook "Turfgrass Science & Culture, 1973 writes: "The most important management practice for OM management is topdressing."

What is the “best” way to get sand into the profile?

Layering

- Water retention is non-uniform
- Thatch/mat layers can store twice as much water than the root zone

Layering alone not that effective
Must topdress to dilute OM (change its pore size distribution) and use deficit irrigation

"the solution to pollution is dilution"
Soil Macropores

Compacted
How do you get rid of OM?

• Decomposition (microbial)
  – Increase surface area and aeration
  – Inoculation

• Removal
  – Power raking, dethatching, core aerification

• Dilution
  – Topdressing

Next steps………. 

When do you topdress?

<table>
<thead>
<tr>
<th>Region</th>
<th>All Year</th>
<th>Warmer Months</th>
<th>Cooler Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northeast</td>
<td>57</td>
<td>29</td>
<td>14</td>
</tr>
<tr>
<td>Central</td>
<td>32</td>
<td>52</td>
<td>16</td>
</tr>
<tr>
<td>Southeast</td>
<td>55</td>
<td>43</td>
<td>2</td>
</tr>
<tr>
<td>West</td>
<td>45</td>
<td>54</td>
<td>1</td>
</tr>
</tbody>
</table>

Data presented as percentages

https://www.golfcourseindustry.com/article/greens-golf-topdressing-agronomics/
**Preferred particle size (mm's):**

<table>
<thead>
<tr>
<th>VC</th>
<th>C</th>
<th>M</th>
<th>F</th>
<th>VF</th>
<th>Silt/Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>0.5-1</td>
<td>0.25-0.5</td>
<td>0.15-0.5</td>
<td>0.05-0.15</td>
<td>0</td>
</tr>
</tbody>
</table>

**Northeast**

| 9 | 13 | 55 | 19 | 4 | 0 |

**Central**

| 2 | 11 | 51 | 35 | 1 | 0 |

**Southeast**

| 0 | 4 | 57 | 35 | 4 | 0 |

**West**

| 2 | 12 | 49 | 32 | 2 | 2 |

Data presented as percentages

https://www.golfcourseindustry.com/article/greens-golf-topdressing-agronomics/

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**Frequency of Heavy Topdressing (per/yr):**

<table>
<thead>
<tr>
<th>1X</th>
<th>2X</th>
<th>3X</th>
<th>&gt;3X</th>
<th>+ Light TD?</th>
</tr>
</thead>
</table>

**Northeast**

| 17 | 45 | 25 | 11 | 85 |

**Central**

| 28 | 50 | 11 | 11 | 86 |

**Southeast**

| 18 | 41 | 21 | 20 | 86 |

**West**

| 19 | 61 | 12 | 7  | 86 |

Data presented as percentages

https://www.golfcourseindustry.com/article/greens-golf-topdressing-agronomics/

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**Frequency of Light Topdressing (days):**

<table>
<thead>
<tr>
<th>7</th>
<th>14</th>
<th>21</th>
<th>28</th>
<th>&gt;28</th>
<th>Same amount?</th>
</tr>
</thead>
</table>

**Northeast**

| 10 | 43  | 15  | 14  | 18   | Yes |

**Central**

| 7  | 42  | 28  | 7   | 16   | Yes |

**Southeast**

| 32 | 56  | 6   | 4   | 2    | No  |

**West**

| 8  | 41  | 24  | 13  | 14   | Yes |

Data presented as percentages

https://www.golfcourseindustry.com/article/greens-golf-topdressing-agronomics/

---

**Sand Particle Size**

<table>
<thead>
<tr>
<th>Particle</th>
<th>Diameter (mm)</th>
<th>Sieve Mesh #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine Gravel</td>
<td>2 – 3.4</td>
<td>10 – 6</td>
</tr>
<tr>
<td>0.5 – 1</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Medium Sand</td>
<td>0.25 – 0.5</td>
<td>60</td>
</tr>
<tr>
<td>Fine Sand</td>
<td>0.15 – 0.25</td>
<td>100</td>
</tr>
<tr>
<td>Very Fine Sand</td>
<td>0.05 – 0.15</td>
<td>270</td>
</tr>
</tbody>
</table>

**Particle Size Distribution for Drainage**

<table>
<thead>
<tr>
<th>Particle Name</th>
<th>Diameter (mm)</th>
<th>Recommendation (by weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine Gravel</td>
<td>2 – 3.4</td>
<td>Not more than 10% total, maximum of 3% fine gravel</td>
</tr>
<tr>
<td>Coarse Sand</td>
<td>0.5 – 1</td>
<td>Minimum of 60%</td>
</tr>
<tr>
<td>Medium Sand</td>
<td>0.25 – 0.5</td>
<td>Not more than 20%</td>
</tr>
<tr>
<td>Fine Sand</td>
<td>0.15 – 0.25</td>
<td>Not more than 5%</td>
</tr>
<tr>
<td>Very Fine Sand</td>
<td>0.05 – 0.15</td>
<td>Not more than 5%</td>
</tr>
<tr>
<td>Silt</td>
<td>0.002 – 0.05</td>
<td>Not more than 3%</td>
</tr>
<tr>
<td>Clay</td>
<td>&lt; 0.002</td>
<td>Not more than 3%</td>
</tr>
<tr>
<td>Total Fines</td>
<td>very fine sand + silt + clay</td>
<td>Less than or equal to 10%</td>
</tr>
</tbody>
</table>

https://www.golfcourseindustry.com/article/greens-golf-topdressing-agronomics/
Research Objectives:

1. Effects of topdressing with sand lacking coarse particles (0.5-mm sand)
2. Does core cultivation and backfilling holes with medium-coarse sand offset any negative effects of topdressing with sands lacking coarse particles?

Research says, so far (3 years)...

1. Topdressing improved the surface:
   • reduced OM concentration
   • produced a drier surface
2. Sand size impacts on mat layer physical properties:
   • medium-fine (>20% fine sand) increased the fineness of sand in mat layer but this did not influence infiltration or VWC
   • medium-coarse and medium-fine similar water infiltration and surface wetness
   • fine-medium sand slowed water infiltration and increased surface water retention
   • fine-medium sand substantially increased fine and very fine particles in mat layer

Managing for Drier Mat Layer

Topdressing
• Cost and interference with play and mowing are limiting factors
• Apply as much and as often as feasible (~48 tons/acre)
• Select as coarse a sand as feasible
  • medium-fine (0.5-mm) sand with less than 30% fine sand

Core Cultivation
• Very effective at producing a drier surface
• Needed if reducing OM is important (follows for more sand incorporation)*
• Time for healing is greatest limitation (less so for solid tines and venting)*

*Gaussoin adds
How much sand to use for topdressing?

- Generic recommendation is 20-40 ft² per 1,000 sq. feet/yr (about 0.5 inch/Mlyr)
  - UNL worked showed 20-24 ft² for OM management
- Varies by amount of:
  - Traffic
  - Grass species or cultivar
  - Nitrogen applied
  - Water applied
  - Microclimate/location

Key is matching your growth rate to optimize topdressing + ________

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Greens Organic Matter Management Tool

An empirical model to predict OM fate in putting green rootzones

buckeyeturf.osu.edu

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Growth Potential

- #clipvol
- Pace Turf
- Micah Woods
- Bill Kreuser
- Others....

---

<table>
<thead>
<tr>
<th>2012 Numbers</th>
<th>2014 Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.0</td>
</tr>
<tr>
<td>2</td>
<td>3.3</td>
</tr>
<tr>
<td>3</td>
<td>3.3</td>
</tr>
<tr>
<td>4</td>
<td>3.3</td>
</tr>
<tr>
<td>5</td>
<td>5.17</td>
</tr>
<tr>
<td>6</td>
<td>5.17</td>
</tr>
<tr>
<td>7</td>
<td>5.10</td>
</tr>
<tr>
<td>8</td>
<td>5.10</td>
</tr>
<tr>
<td>9</td>
<td>5.19</td>
</tr>
<tr>
<td>10</td>
<td>6.05</td>
</tr>
<tr>
<td>11</td>
<td>6.05</td>
</tr>
<tr>
<td>12</td>
<td>5.96</td>
</tr>
<tr>
<td>13</td>
<td>5.3</td>
</tr>
<tr>
<td>14</td>
<td>3.2</td>
</tr>
<tr>
<td>15</td>
<td>2.68</td>
</tr>
<tr>
<td>16</td>
<td>2.94</td>
</tr>
<tr>
<td>17</td>
<td>4.28</td>
</tr>
<tr>
<td>18</td>
<td>4.13</td>
</tr>
<tr>
<td>19</td>
<td>3.57</td>
</tr>
<tr>
<td>20</td>
<td>3.57</td>
</tr>
</tbody>
</table>

Increased sand and only solid tine implemented in 2015/16
Organic Matter Next Steps at UNL…

• “the solution to pollution is dilution”
• Next Steps
  • Can you determine organic matter at your facility without the help of a lab?
  • Topdressing impacts on structure and fluid dynamics

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Pro Core 648
3/8” solid tines

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How is it normally done at a lab?

Loss on Ignition (LOI)

• 100-1200°C
• Sample is weighed, placed in oven, then weighed again
• OM% determined by subtraction
• Ovens are $1200-2500

---

Conclusions

- Grooming medium significantly altered in 4 years.
- Inflation rate increased.
- Lower and/or more consistent %OM throughout your greens gives you more control.
- Performance is extremely consistent with golf shots being received the same throughout the course.
- We will continue to sample the greens for %OM each February and August to make informed decisions on what to do next.
- Our attention process is simple and fast. The staff and membership are equally pleased with process and results.
- This program has become the backbone of what we do. The unit of %OM is the most important tool in our bag and has allowed us to produce consistent greens that perform far better than before this program was implemented.
- Regardless of whether you pull a core or solid-tine, testing each green and then knowing how much sand to use is essential to producing consistent greens.

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Hydrogen Peroxide

• Hydrogen peroxide is a chemical compound (H₂O₂). In its pure form, it is a very pale blue, clear liquid, slightly more viscous than water. It is used as an oxidizer, bleaching agent, and antiseptic.
  • Readily available & inexpensive
  • Well documented to “digest” OM
  • We have started testing

---

On course testing as an OM management tool
OM Testing

- Know how your sample was taken and compare notes with others that use the same protocol
- Take annual tests to determine long-term trend
  - Same time of year
  - Same location and green *(or all greens!)*
- Correlate your test results with turf quality and performance during stressful environmental conditions to determine need for changes in management program
- Threshold/critical levels likely vary across the United States and from course to course

Clarification/over-simplification regarding OM Management on sand based rootzones

- One size does not fit all
- The optimal % OM has not been scientifically/universally determined and may be mythical
- Cultivation is critical to increase efficiency in sand incorporation
- Solid are not different than coring tines
- The benefits of topdressing continue to be identified.
Acknowledgements

Nebraska Turfgrass Association