Understanding and Managing Organic Matter Accumulation in Cool-Season Greens

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Delta, Ocean Pointe Resort,
Victoria, BC

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What do we want to learn today?

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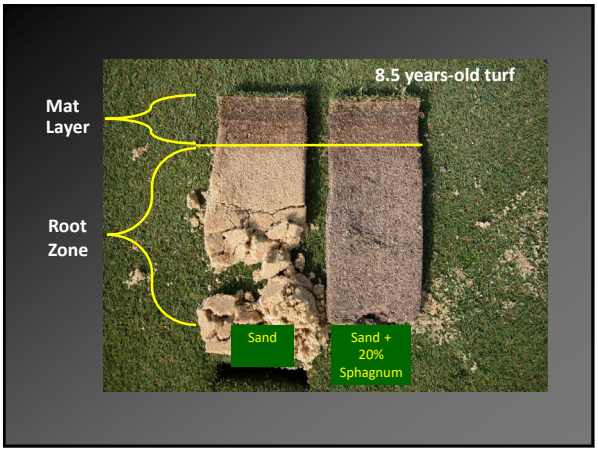

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~~The~~ *My* organic matter journey……

- 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.

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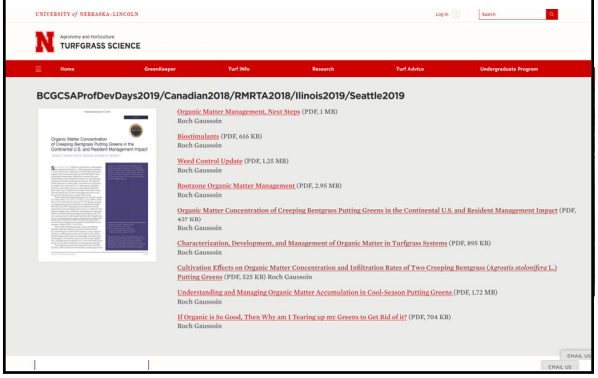
https://turf.unl.edu/



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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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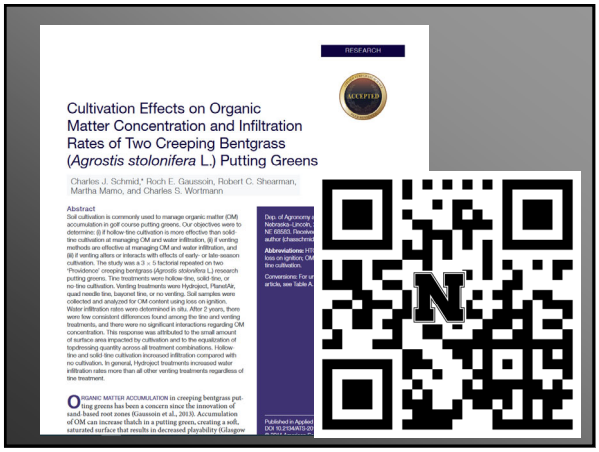

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Organic matter development: ***Are We the Problem?***

Or:

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

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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

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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

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Where does organic matter accumulate?

- Above ground
  - Thatch/Mat
  - clipping residue
    - relatively short term
    - "pseudo" thatch
- Below ground
  - rootzone
  - rhizosphere

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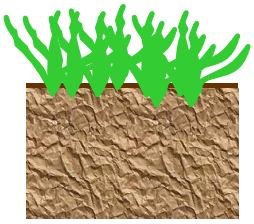
Importance of (P)OM in the rhizosphere

- deposition of particulate OM
- microbial niches
- nutrient uptake
- pathogen competition



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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

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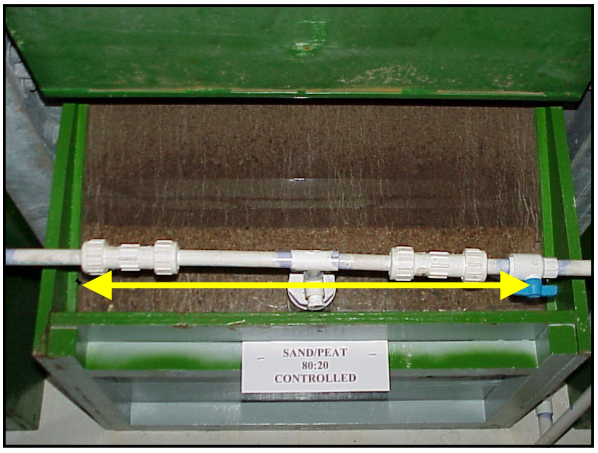

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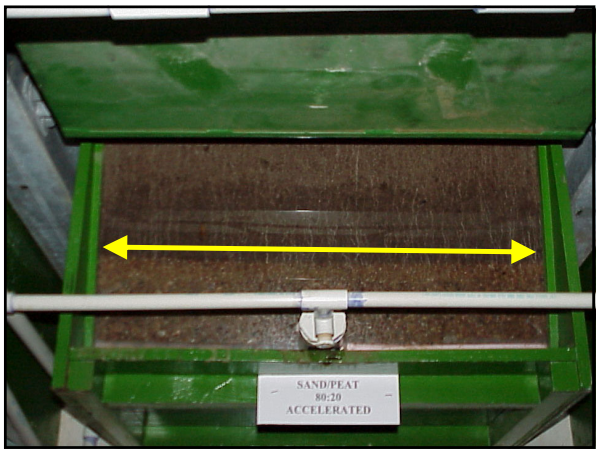

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Rootzone accumulation yearly in sand green

Year 1	2	3
0.65%	6.0%	3.0%

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

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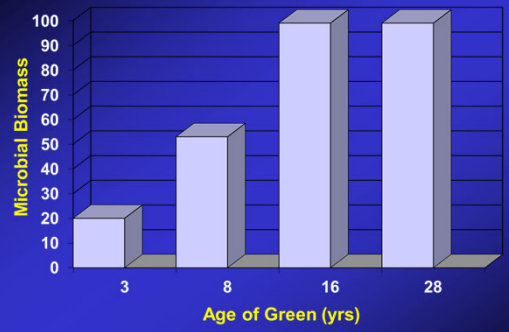
Green Age Effects on Microbial Biomass



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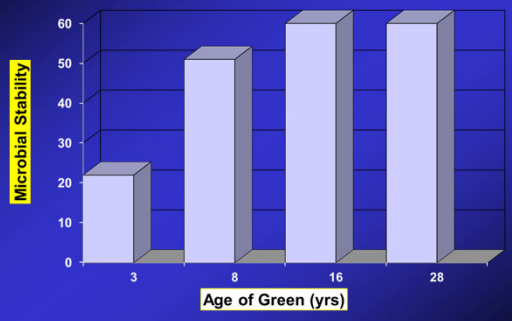
Green Age Effects on Microbial Stability



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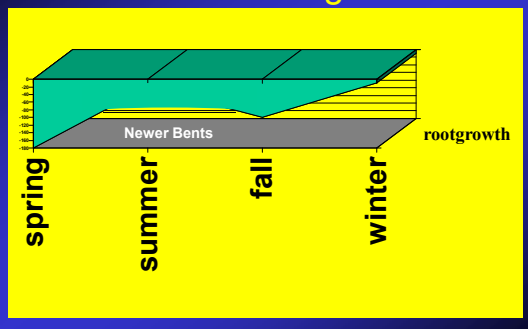
Rootzone accumulation seasonal root growth



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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

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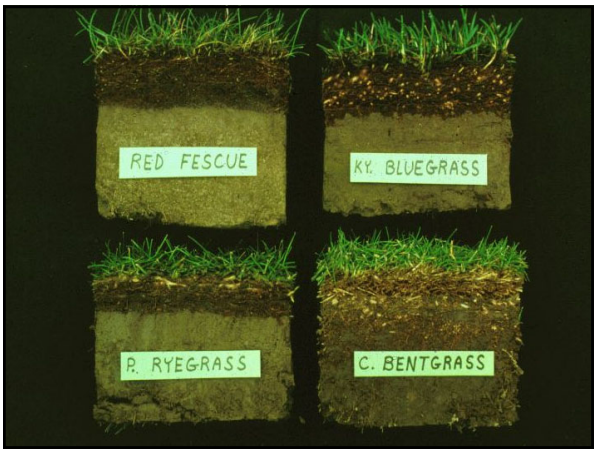

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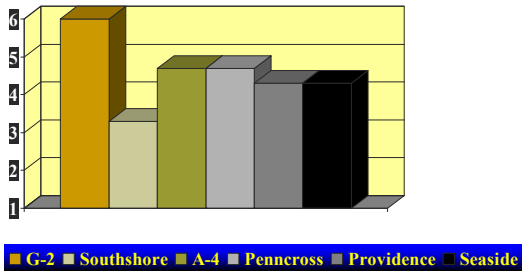
Greens Height Bentgrass Thatch Thickness (mm)



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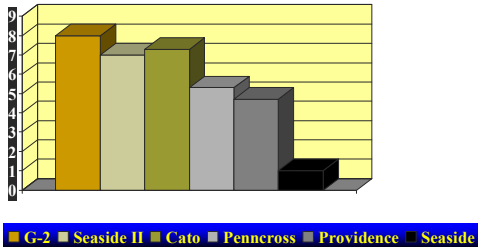
Fairway Height Bentgrass Thatch Thickness (mm)



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Benefits of "Moderate" Thatch

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

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Problems with excessive thatch

- Footprinting

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Problems with excessive thatch

- Scalping

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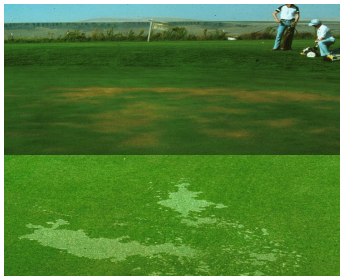
Problems with excessive thatch

- LDS



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Doug Soldat's work at UW

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

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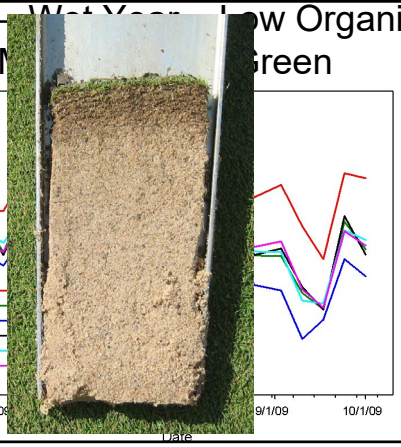
2009 – Wet Year – Low Organic Matter Putting Green



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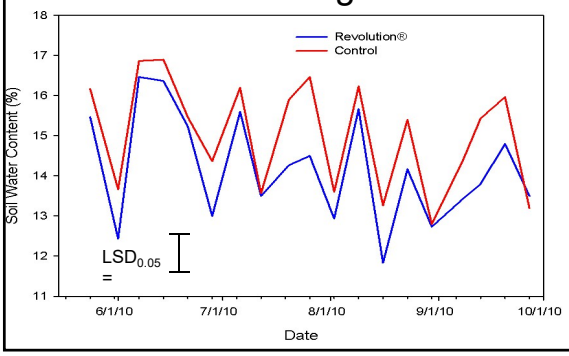
2010 – Wet Year – Low Organic Matter Putting Green



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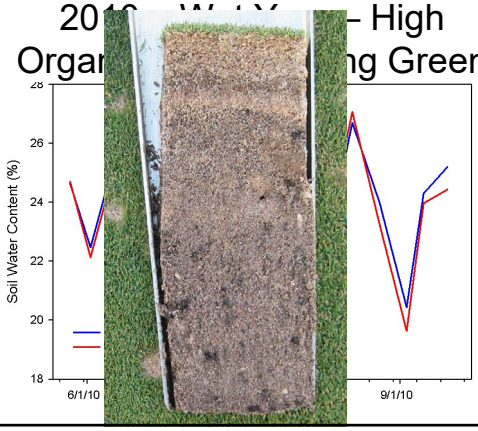
201– Wet Year – High Organ– Matter Putting Green



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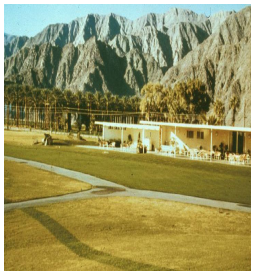
Problems with excessive thatch

- Reduced Stress Tolerance



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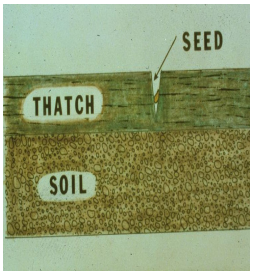
Problems with excessive thatch

- Overseeding Failure



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Mat

Thatch that has been intermixed with mineral (soil) matter

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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).

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and yet one more definition……..

SOM- Soil Organic Matter

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Physical And Chemical Characteristics Of Aging Golf Greens

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

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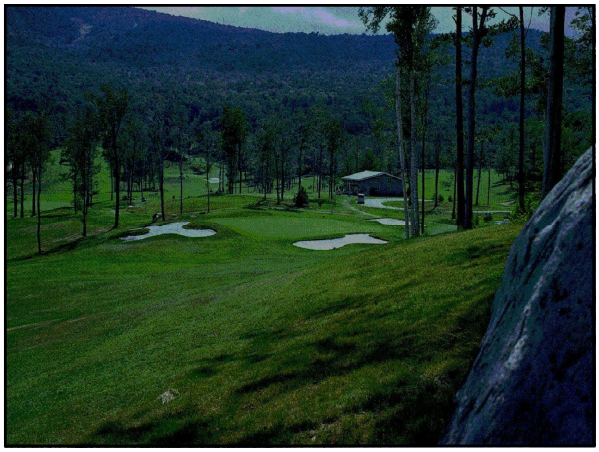

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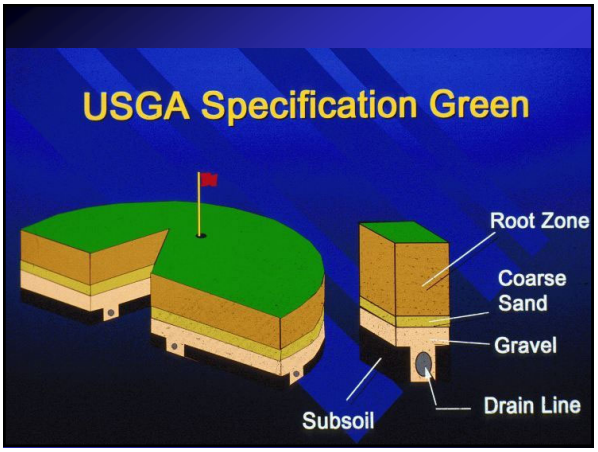

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Treatments

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

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Project Schedule (Phase I)

1996 | 1997 | 1998 | 1999 | 2000

Greens construction (one set per year)

Seeding

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

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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.

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Materials and Methods

9 yr old green	10 yr old green	12 yr old green	13 yr old green

As of 2009

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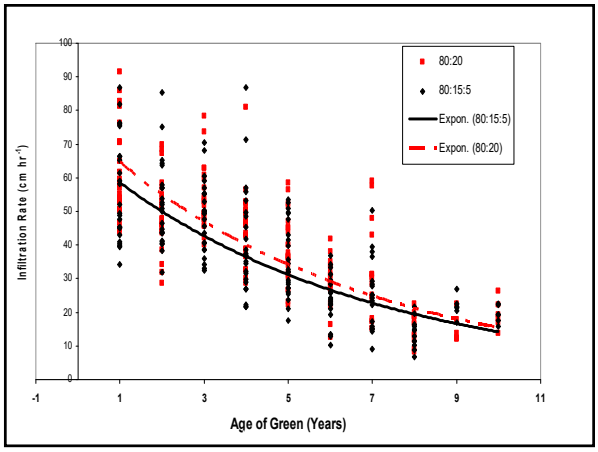

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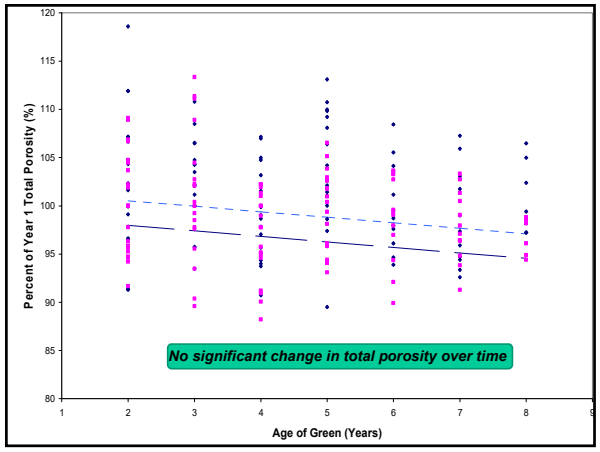

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Large Pores

Small Pores

Significant decrease in macro-porosity over time

Significant increase in micro-porosity over time

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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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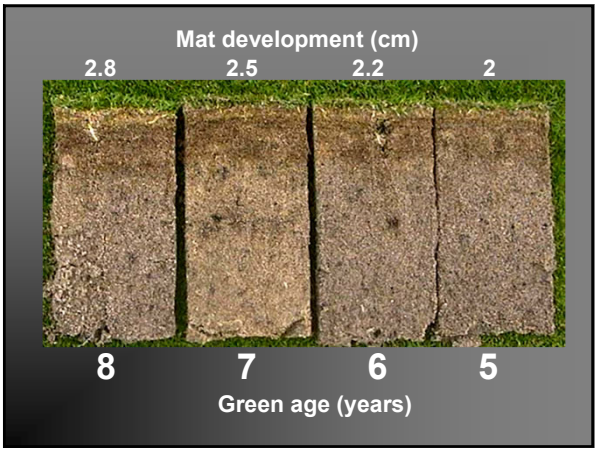

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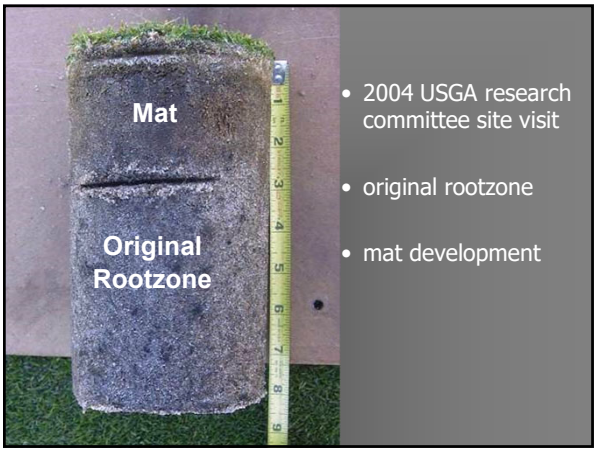

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Materials and Methods

- 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

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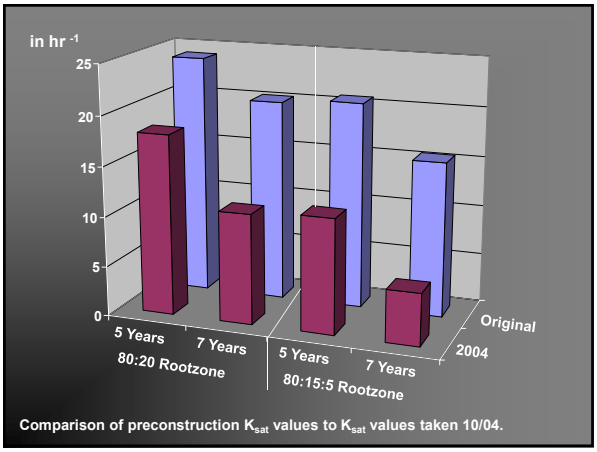

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Change in Rootzone Particle Size Distribution

- 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.

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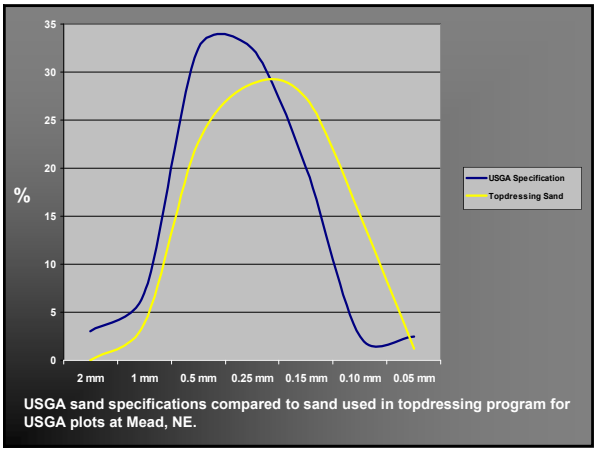

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Conclusions

- 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

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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.

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Want to know more?

- Gaussoin, R., R. Shearman, L. Wit, T. McClellan, and J. Lewis. 2007. Soil physical and chemical characteristics of aging golf greens. *Golf Course Manage.* 75(1):p. 161-165.

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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?

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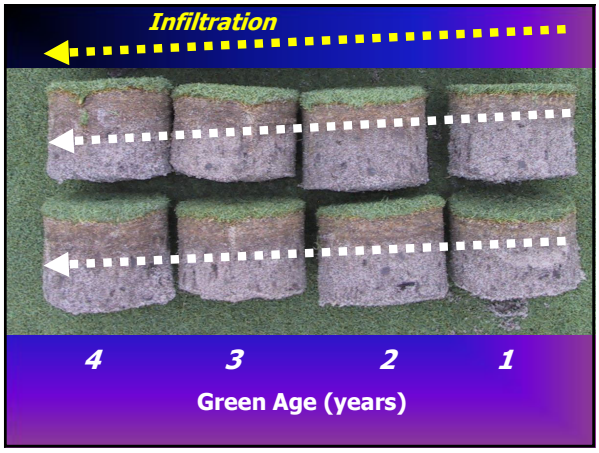

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all slides with the USGA logo in the corner are courtesy of Paul Vermeulen. Director, Competitions Agronomy at PGA TOUR, former USGA Agronomist

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Organic Matter Recommendations

2.5 3.0 3.5 4.0 4.5 5.0 5.5

Low High

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

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Sampling of Recommendations

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

Lowe: < 3 - 4%

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

Hartwiger & O'Brien: < 3.5 – 4.5%

2.5 3.0 3.5 4.0 4.5 5.0 5.5

Low High

Carrow: < 3%

McCoy: < 3.5%

Adams: < 5%

N.Z. Turf In.: < 8%

J. W. Murphy: < 4.5%

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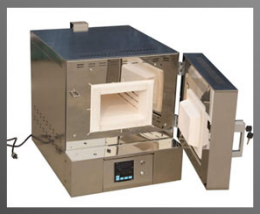
Analysis Methods

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



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Organic Matter Sampling Protocols

2.5 3.0 3.5 4.0 4.5 5.0 5.5

Low High

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

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There is no "magic" number

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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

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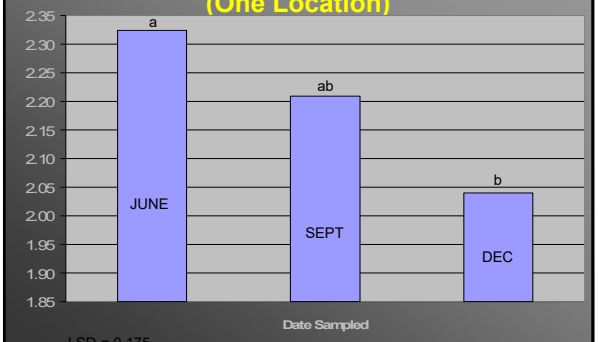
Seasonal Variation
(One Location)



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How do you get rid of OM?

?????

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How do you get rid of OM?

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

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Organic Matter Degradation Study

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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

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Locations

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

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Plot Set-Up
14 Treatments, 3 Reps

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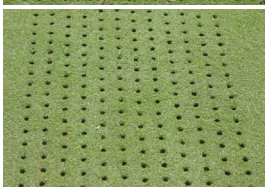
Each Plot Aerified before Application of products



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Data Collection

- **Infiltration**
- **Penotrometer**
- **Thatch**
- **Organic Matter**
  - Thatch, 0-3", 3-6"

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Analysis Summary

Source	Thatch (mm)	Clegg (g)	Infiltrat (in/hr)	Thatch (OM %)	0-3" (OM %)	3-6" (OM %)
Site	**	*	**	**	**	**
Trtmnt	NS	NS	NS	NS	NS	NS
Site X Trtmnt	NS	*(0.10)*	NS	NS	*	NS

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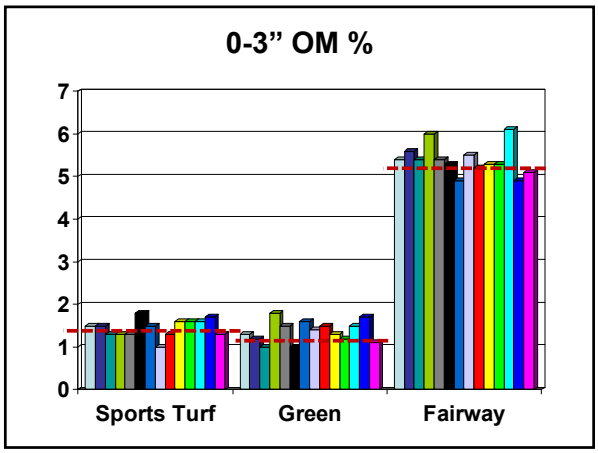

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Summary

- No product increased degradation of OM

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How effective is removal?

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

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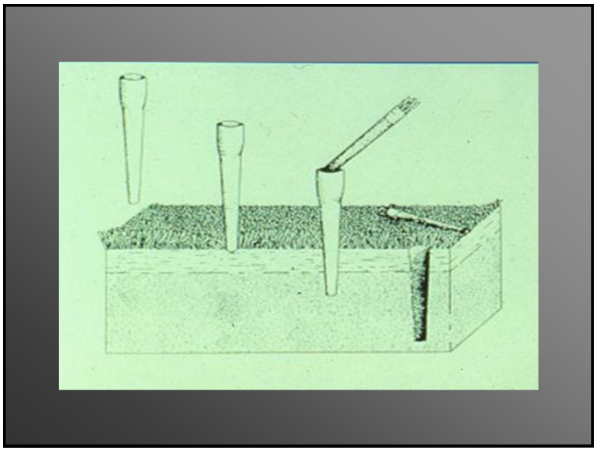

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Tine Size and Surface Area Chart

Tine Size	Spacing (in.)	Holes/ft^2	Surface Area of One Tine	Percent Surface Area Affected
¼"	1.25^2	100	0.049	3.4%
¼"	2.5^2	25	0.049	0.9%
½"	1.25^2	100	0.196	13.6%
½"	2.5^2	25	0.196	3.4%
5/8"	2.5^2	25	3.07	5.3%

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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)

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Project Objective

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

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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***

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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

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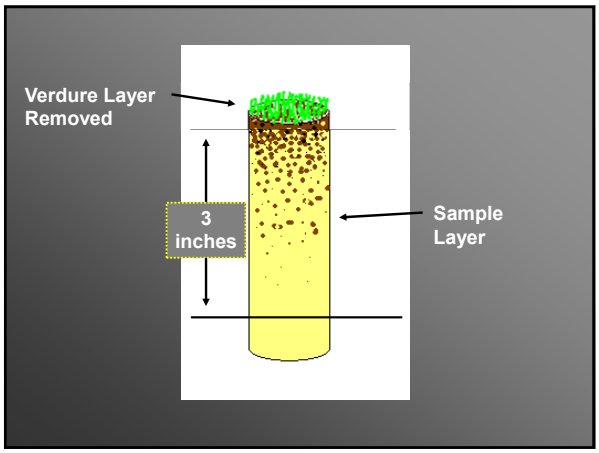

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2006/07/08 Samples

- Sixteen states
  - Nebraska, South Dakota, Iowa, Wyoming, Colorado, Washington, Wisconsin, Illinois, New Jersey, Minnesota, New Mexico, Montana, Hawaii, California, Connecticut, Arkansas.
- 117 golf courses sampled
  - More than 1600 samples

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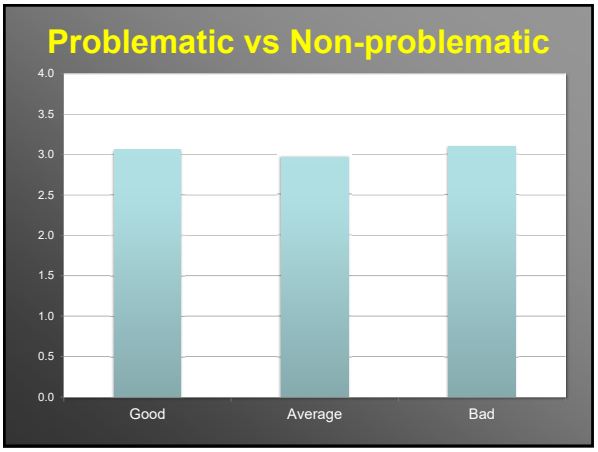

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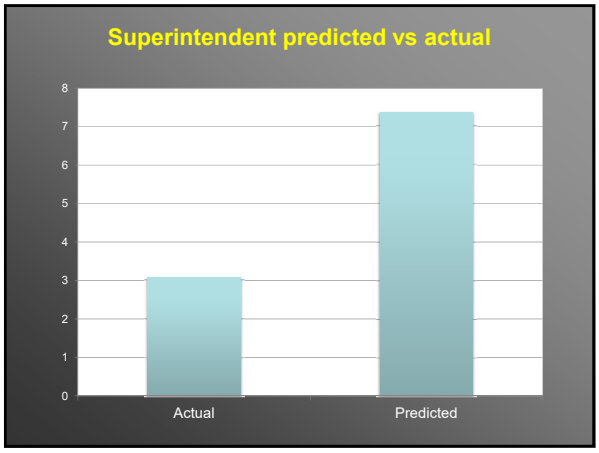

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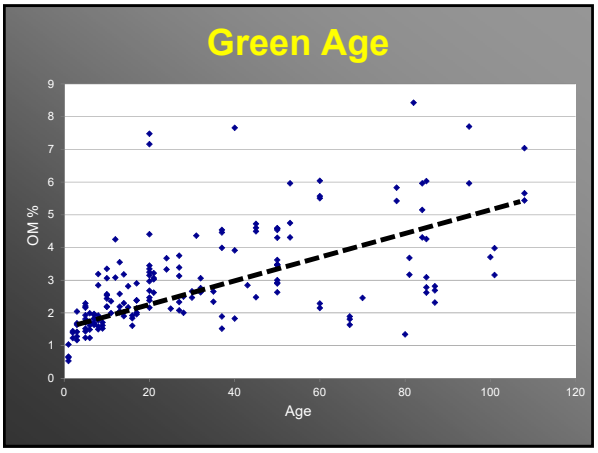
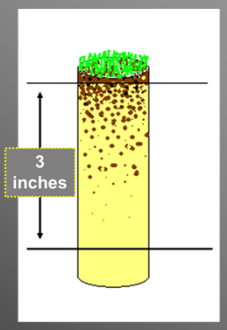


102

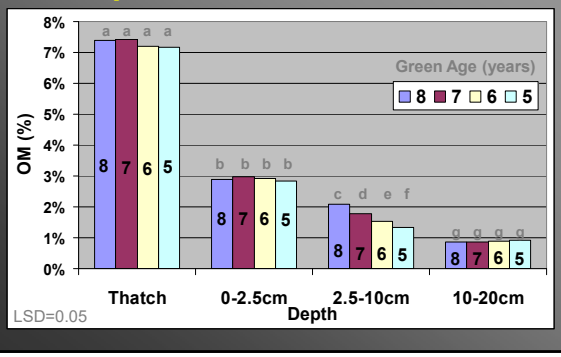
Is the age effect misleading?

- Sampling issue:
  - Mat depth increases as green ages resulting in more OM in the same volume soil.



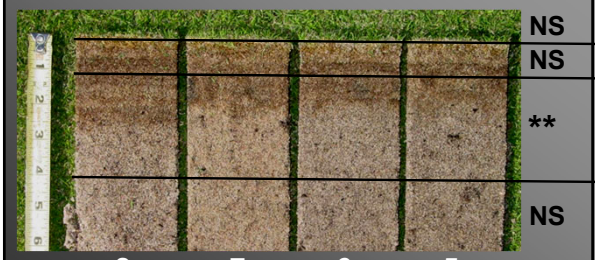
103

Organic Matter in USGA Specification Rootzones



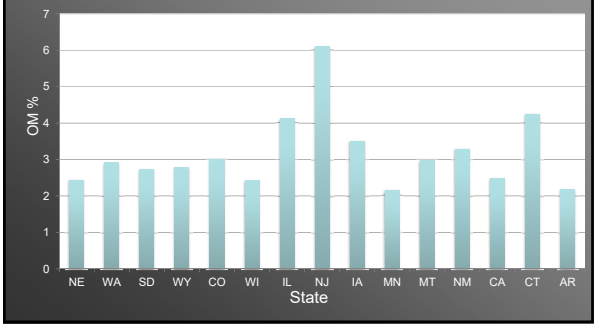
104

Mat Development with Age



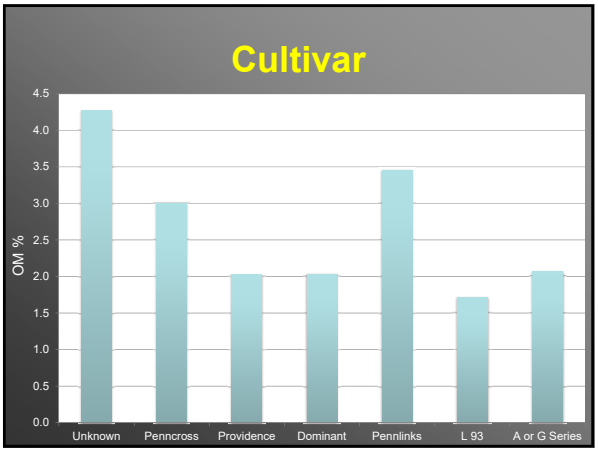
105

State Differences (highly correlated with age)



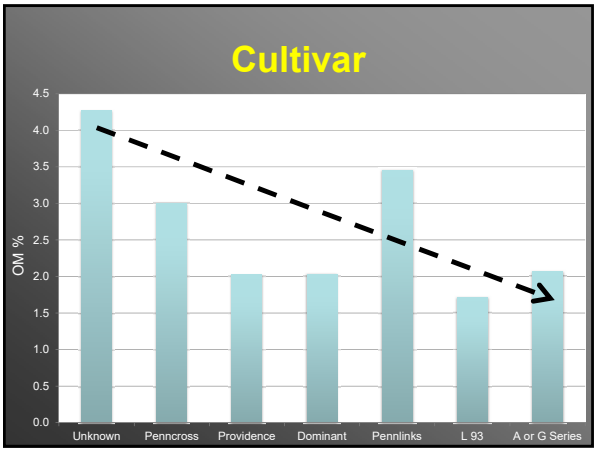
106

Cultivar



107

Cultivar



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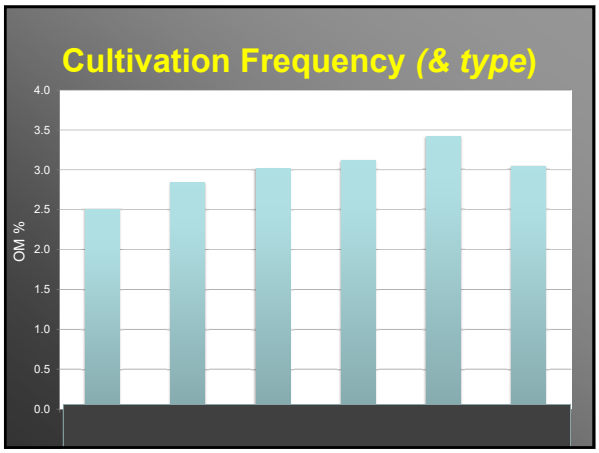

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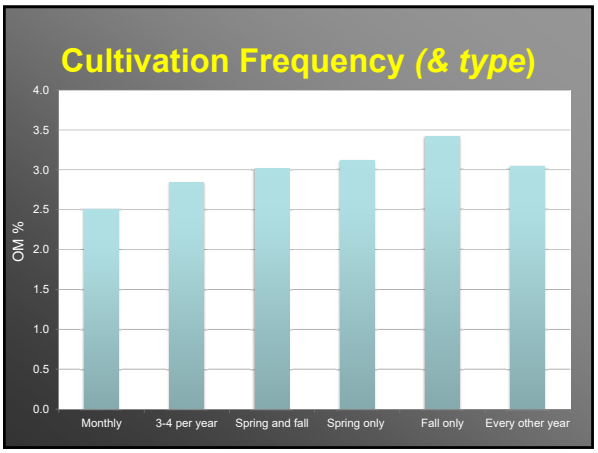

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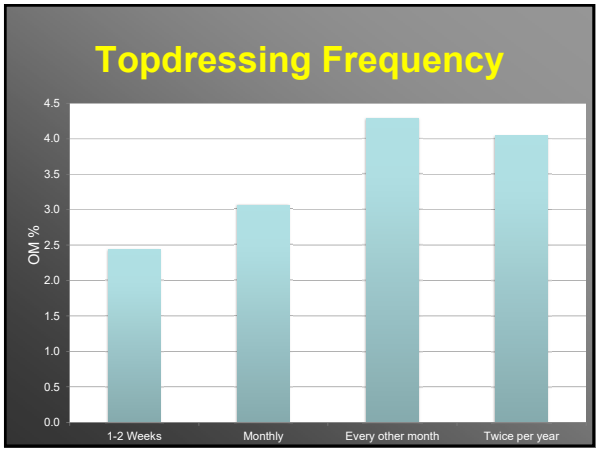

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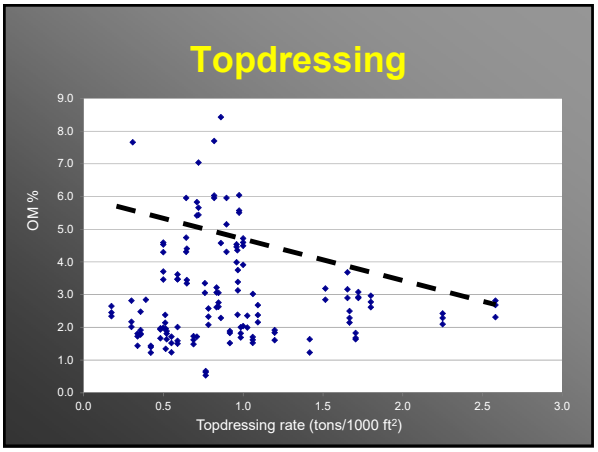


112

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

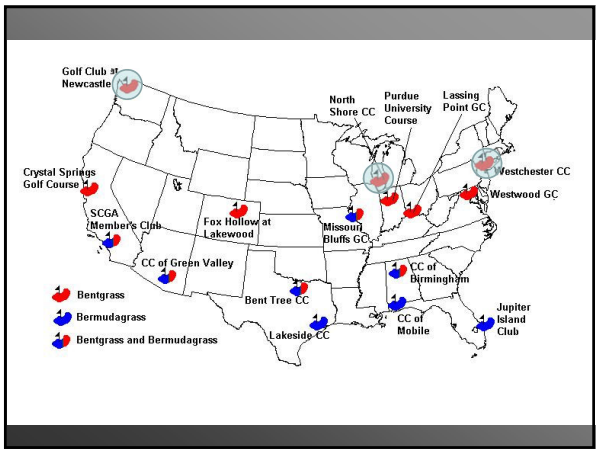
**1 ft³ = 100 lbs of dry sand; yd³ = 2700 lbs*

113

Onsite NTEP Cultivar Evaluation

1	L-93	10	SR 1020
2	Putter	11	SR 1119
3	Cato	12	Viper
4	Crenshaw	13	Century
5	LCB-103	14	Imperial
6	Penncross	15	Penn A-1
7	Backspin	16	Penn A-4
8	Trueline	17	Penn G-6
9	Providence	18	Penn G-1

114



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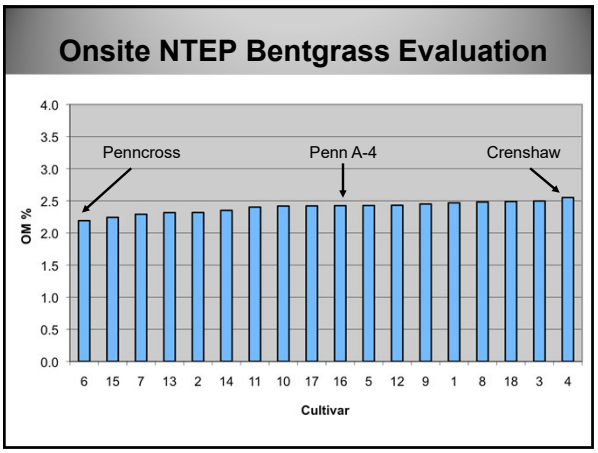


116

"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

117

Topdressing and the new bents

Easy or hard???

118

119

120

New bents = denser and more upright

121

Pulling cores or poking holes?

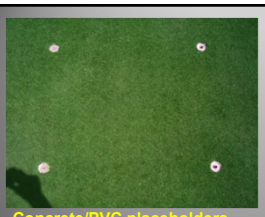
- In 2005, 45 of 141 courses surveyed* planned no core removal
  - Many had not pulled cores for 2-20 years
- 75 planned to pull cores
  - 35 of the 75 had no agronomic reason to pull a core (based on USGA Agronomist evaluation) while 40 "needed" to pull cores
- With current and evolving cultivation/topdressing/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

* *Mid-continent region USGA*

122

Let's take a quick look at that…

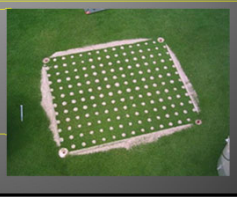
123



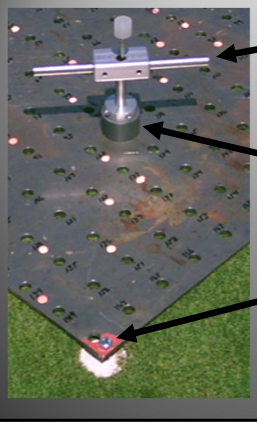
Concrete/PVC placeholders

Template with 0.5" diameter cores at 2.5" spacing

Cores removed to 5" depth; cores filled with sand topdressing



124



Modified soil probe simulates 0.5" diameter hollow-tine core aeration

Stabilizer block to ensure vertical probe entry

Bolts insert into placeholders to ensure exact location for resampling

125

- 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"

126

		Time after core creation (weeks)							
		2	4	6	8	10	12	14	16
Putting Green	Depth	Organic Matter Reduction (%)							
9 yr	3”	*79*	73	70	71	69	66	67	*66*
	6”	*71*	64	60	63	59	56	57	*56*
5 yr	3”	*73*	66	61	62	62	62	61	*59*
	6”	*66*	56	51	51	52	52	51	*49*

127

Organic Matter Management Study

Objectives

1. Determine if conventional hollow tine is more effective than solid tine aerification at managing organic matter accumulation

128

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

129

Treatments

Tine Treatment	Venting Treatment
None	None
2X Hollow tine	PlanetAir
2x Solid tine	Hydroject
	Bayonet tine
	Needle tine

15 Trts per Rep
6 Reps per year
2 different years
= A whole lot of fun for one graduate student or 180 trts

130

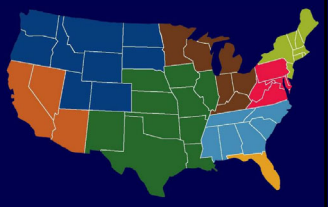
131

All treatments received the same topdressing quantity (22 ft^3/M) but different frequency

132

Regional Survey

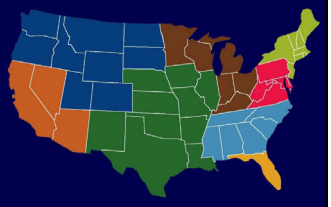
- Annual topdressing rate for 10 well maintained courses in each region
  - Stable maintenance program during past 5 growing seasons
  - Same general turf conditions
- Surveys are not research!
  - Fertility
  - Traffic
  - Green construction
  - Etc.



133

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.



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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

135

All treatments received the same topdressing quantity (22 ft^3/M) but different frequency

Equilibrated to identify differences of the practices in question

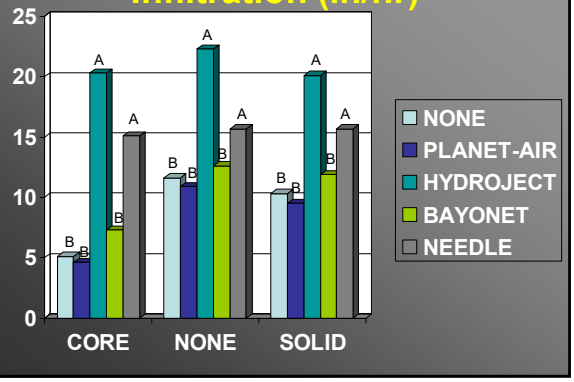
136

Materials and Methods

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

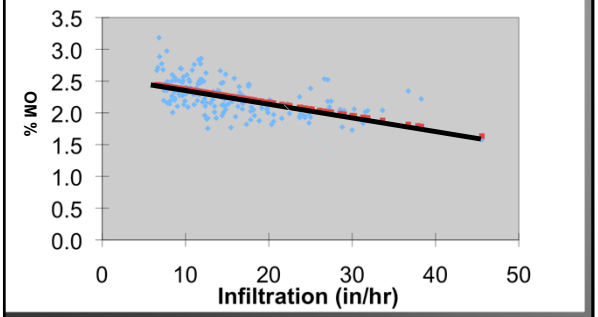
137

Infiltration (in/hr)



138

Relationship between OM and Infiltration



*Significant at α = 0.01

139

OM Data Analysis Year 1

- No differences between green age except for higher % in older green

140

OM Data Analysis Year 1

- No differences between green age except for higher % in older green
- No differences among venting methods

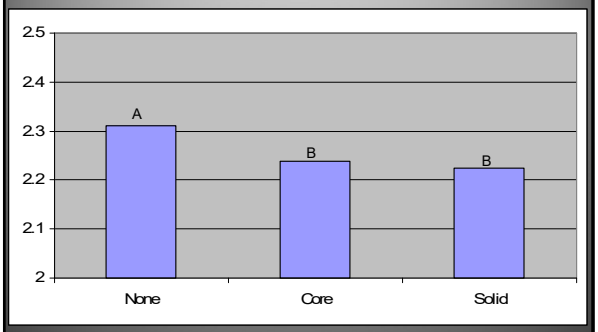
141

OM Data Analysis Year 1

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

142

Effect of Aerification on OM



143

OM Data Analysis Year 2

- No differences between green age except for higher % in older green

144

OM Data Analysis Year 2

- No differences between green age except for higher % in older green
- No differences among venting methods

145

OM Data Analysis Year 2

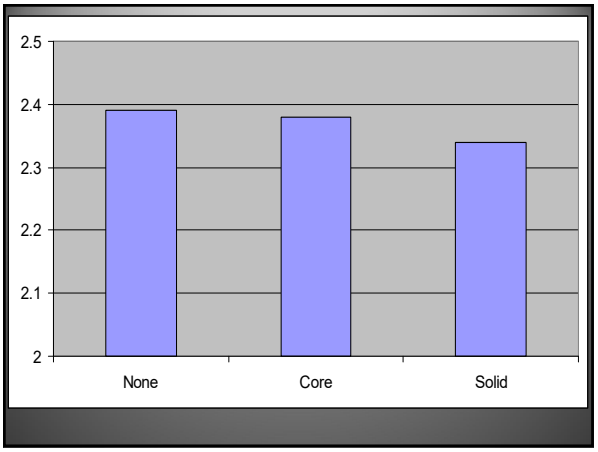
- No differences between green age except for higher % in older green
- No differences among venting methods
- No interactions with solid/hollow/none

146

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

147



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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

149

*Topdressing interval relative to t 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

150

151

GreenKeeper Survey

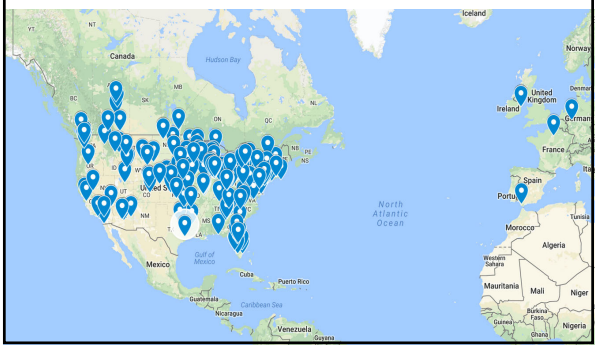
cool season only, mark all that apply

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.

152

Survey Respondents via Greenkeeper



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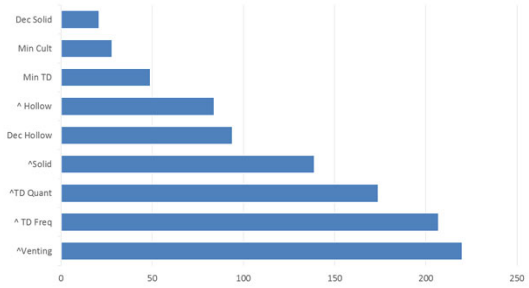
303 Responses



154

https://www.usga.org/course-care/green-section-record/57/19/is-solid-tine-aeration-right-for-your-greens-.html

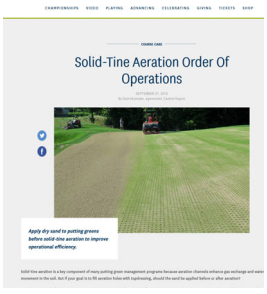
WEST REGIONAL UPDATE

Is Solid-Tine Aeration Right For Your Greens?

Aerating greens with solid tines is becoming more popular, which helps to speed up the aeration process while still filling the holes with sand to dilute thatch and organic matter.

155

https://www.usga.org/content/usga/home-page/course-care/regional-updates/central-region/2018/solid-tine-aeration-order-of-operations.html



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"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."

157

"the solution to pollution is dilution"

158

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"

159

What is the "best" way to get sand into the profile?

160

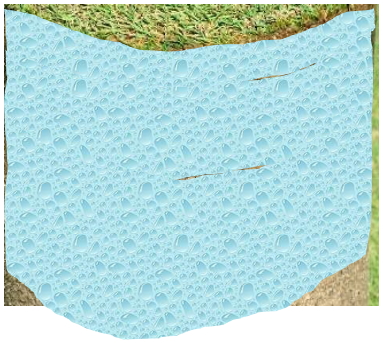
Layering

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

NOT a function of drainage

Rather it is the difference in pore size distribution among layers

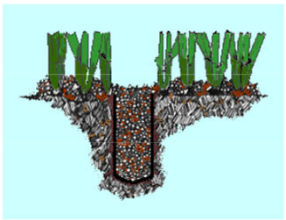
161



162

Layering

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

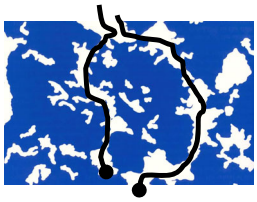


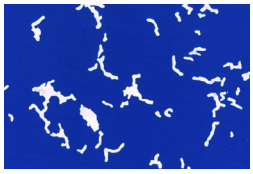
163

"the solution to pollution is dilution"

164

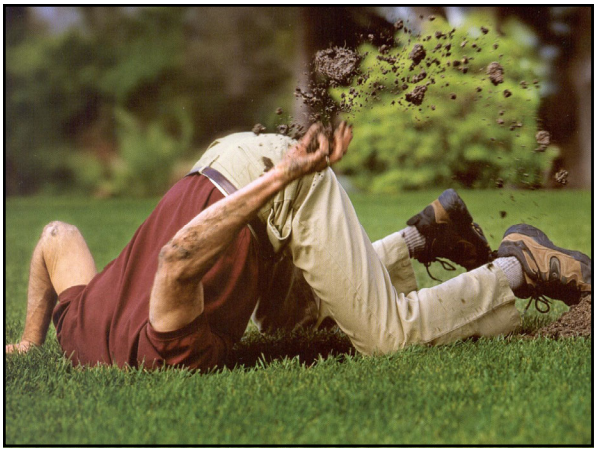
Soil Macropores





Compacted

165



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How do you get rid of OM?

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

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GOLF COURSE INDUSTRY

THE VOICE FOR TODAY'S SUPERINTENDENT

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Golf Course Industry Magazine | April 2018

True Grit

Features - Special Report

In the first of a two-part series, turf managers offer their views on their methodology for sanding greens and providing top-notch playing surfaces.

April 11, 2018

The unmistakable surface sheen is testament that the greens have been topdressed. An undeniably important agronomic process for golf course superintendents, it's also one not entirely appreciated by

sponsored by

The Hayden Group Inc.

PREMIER SAND

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

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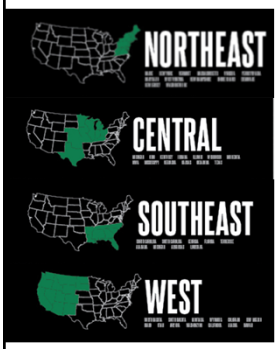

Does your TD sand meet USGA specs?

90%

77%

72%

88%

180

When do you topdress?

	All Year	Warmer Months	Cooler Months
Northeast	57	29	14
Central	32	52	16
Southeast	55	43	2
West	45	54	1

Data presented as percentages

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

181

Preferred particle size (mm's):

	VC 1-2	C 0.5-1	M 0.25-0.5	F 0.15-0.5	VF 0.05-0.15	Silt/ Clay
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):

	1X	2X	3X	>3X	*+ Light TD?*
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/

183

Frequency of Light Topdressing (days):

	7	14	21	28	>28	*Same amount?*
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/

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RUTGERS
THE STATE UNIVERSITY OF NEW JERSEY

Topdressing Sand: Sorting Out What Matters

Nebraska Turf Conference
Wednesday, January 9, 2019
9:00 – 9:45 a.m.

James A. Murphy, Ph.D.
Extension Specialist in Turfgrass Management

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Sand Particle Size

Particle	Diameter (mm)	Sieve Mesh #
Fine Gravel	2 – 3.4	10 – 6
V. Coarse Sand	1 – 2	18
Coarse Sand	0.5 – 1	35
Medium Sand	0.25 – 0.5	60
Fine Sand	0.15 – 0.25	100
Very Fine Sand	0.05 – 0.15	270

Difficult to incorporate

186

Particle Size Distribution for Drainage

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

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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?

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Sand Size	2-1 mm Very Coarse	1-0.5 mm Coarse	0.5-0.25 mm Medium	0.25-0.15 mm Fine	0.15-0.05 mm Very Fine
	---------- % (by weight) retained ----------				
Medium-coarse (1-mm)	0	30	60	10	< 1
Medium-fine (0.5-mm)	0	0	74	24	2
Fine-medium	0	4	27	48	21

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Treatment No.	Factors in the Experiment: Sand Size	Topdressing Rate during Growing Season	Cultivation (twice/year; May & Oct): Hollow Tine	Cultivation (twice/year; May & Oct): Backfill / Topdress	Annual Quantity of Sand Applied
		lbs. / 1,000-sq.-ft.		lbs. / 1,000-sq.-ft.	lbs. / 1,000-sq.-ft.
1	Medium-coarse	50	None	400	1,300
2	Medium-coarse	50	Core + Backfill	600	1,700
3	Medium-coarse	100	None	400	1,800
4	Medium-coarse	100	Core + Backfill	600	2,200
5	Medium-fine	50	None	400	1,300
6	Medium-fine	50	Core + Backfill	600	1,700
7	Medium-fine	100	None	400	1,800
8	Medium-fine	100	Core + Backfill	600	2,200
9	Fine-medium	50	None	400	1,300
10	Fine-medium	50	Core + Backfill	600	1,700
11	Fine-medium	100	None	400	1,800
12	Fine-medium	100	Core + Backfill	600	2,200
13	None	0	None	0	0
14	None	0	Core + Backfill	600	1,200

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Research says, so far (3 years)…

1. Topdressing improved the surface:
   - reduced the 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

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Research says, so far (3 years)…

3. Core cultivation and backfilling with medium-coarse sand very effective at:
   - reduces surface wetness and OM concentration
   - reduces the amount of fine and very fine sand in the mat layer, thus offsetting the negative impact of those particles

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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 30% fine sand

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

**Gaussoin adds*

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How much sand to use for topdressing?

- Generic recommendation is 20-40 ft^3 per 1000 sq. feet/yr (about 0.5 inch/M/yr)
  - ***UNL worked showed 20-24 ft^3 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

A Location-Based Model of Organic Matter Fate within the Sand-Based Surface Layer of a Putting Green
Ed McCoy
Ohio State University

Introduction
Managing soil organic matter (SOM) in golf course putting greens is a major agronomic challenge facing golf course superintendents. If organic matter levels become excessive, the putting surface will be soft, bumpy and prone to disease and scalping. Yet measures to control organic matter accumulation such as topdressing and core aeration are commonly disruptive and result in player dissatisfaction and reduced course revenues. This article describes a location-based simulation model of organic matter accumulation, mineralization, dilution and removal to track the fate of SOM in the sand-based surface layer of

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….

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Wing Point GOLF & COUNTRY CLUB
Bainbridge Island, WA

Mike Goldsberry
Golf Course Superintendent

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- What is it that makes greens different? Essentially, two contributing factors.
  - Sunlight = growth
  - Soil medium = growth, infiltration rate, fertilizer leaching, wilting point, firmness, cold weather tolerance, air porosity
- How do we know if each greens soil medium is different without testing for % Organic Matter?
- Why are we aerating all the greens the same if they're all different?
- What are we really trying to accomplish when we aerate our greens twice a year? Many things we all know about, but mostly it's our chance to actually incorporate sand into the profile in order to mange the ongoing accumulation of OM. We're basically using these two opportunities to balance things out.
- What's the best method for making sure we have good incorporation of sand into the aeration holes?

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2012 Numbers

Green	% OM Feb, 2012
1	3.02
2	3.5
3	3.05
4	2.91
5	3.37
6	3.87
7	3.28
8	3.89
9	3.89
10	3.09
11	3.31
12	3.96
13	3.3
14	3.27
15	2.89
16	2.94
17	4.28
18	4.3
Putter	3.57
Chipper	4.53

2014 Numbers

Green	% OM Feb, 2014
1	3.31
2	3.4
3	3.89
4	3.08
5	3.52
6	3.12
7	2.66
8	3.3
9	3.35
10	3.16
11	3.31
12	3.06
13	3.41
14	3.19
15	2.74
16	3.14
17	3.96
18	3.48
Putter	3.03
Chipper	3.09

Increased sand and only solid tine implemented in 2013/14

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1.) Low %OM greens received a top dressing in 3rd gear and aerated 1 time

2.) Desired %OM greens received a top dressing in 2nd gear and aerated 2 times

3.) High %OM greens received a top dressing in 1st gear and aerated 3 times

- 1st gear low was 2.5 mph
  - 38% more sand than 2nd gear
- 2nd gear low was 4 mph
  - This has been our standard gear for aeration
- 3rd gear low was 7 mph
  - 43% less sand than 2nd gear

Pro Core 648
3/8" solid tines

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Green	% OM Feb, 2012	%OM Feb, 2016
1	3.02	2.65
2	3.5	2.34
3	3.05	2.49
4	2.91	2.66
5	3.37	2.62
6	3.87	2.9
7	3.28	2.45
8	3.89	2.52
9	3.89	3.03
10	3.09	2.9
11	3.31	2.65
12	3.96	2.58
13	3.3	2.96
14	3.27	2.53
15	2.89	2.58
16	2.94	2.51
17	4.28	3.04
18	4.3	2.64
Putter	3.57	2.73
Chipper	4.53	2.56

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Conclusions

- Growing medium significantly altered in 4 years.
- Infiltration rate increased.
- Lower and/or more consistent %OM throughout your greens gives you more control.
- Wilt point much higher.
- Playability 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 aeration 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 box and has allowed us to produce consistent greens that perform far better than before this program was implimented.
- 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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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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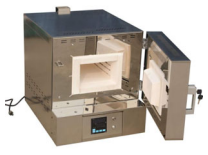
How is it normally done at a lab?

Loss on Ignition (LOI)



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

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Hydrogen Peroxide

- Hydrogen peroxide is a chemical compound (H_2O_2). 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

PURE OXYGEN LAB
WORLD REVOLUTION IN THE TURF INDUSTRY
by TOP GOLF SERVICES

On course testing as an OM management tool

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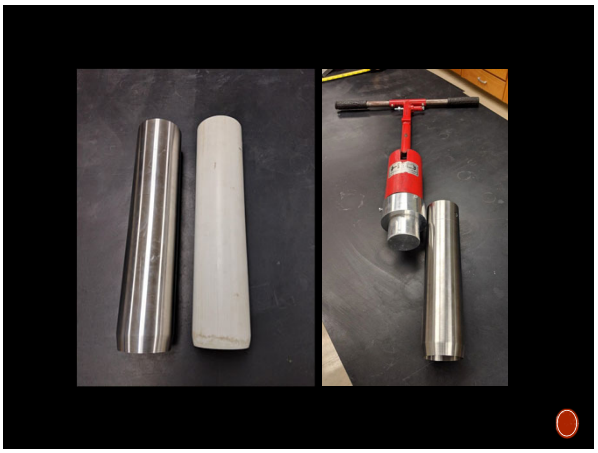
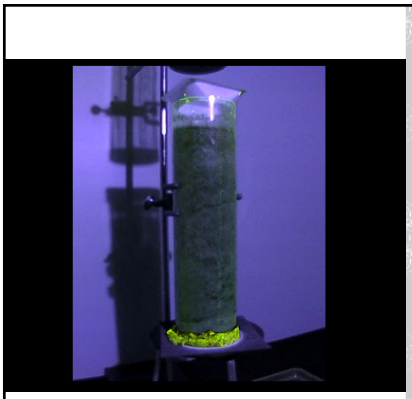


206



FIRST VIDEO: NOVEMBER 2018

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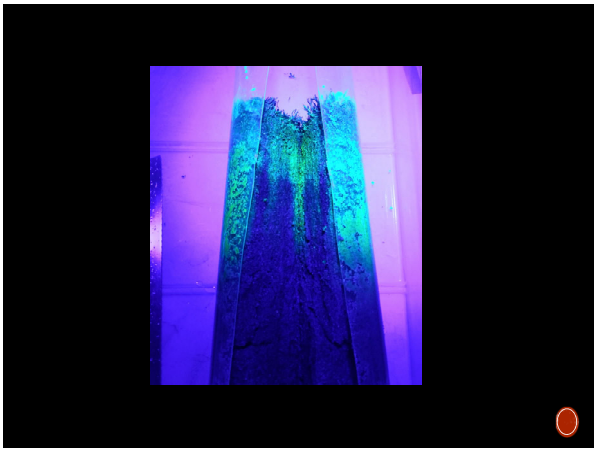

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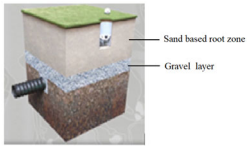
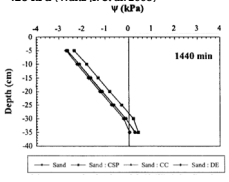
TENSION TABLE

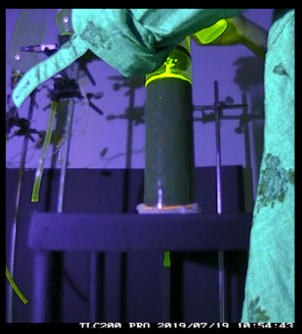
Tension exists at the bottom of a putting green root zone due to a hanging water column



Use tension table to replicate this tension:
-.25 kPa (Waltz Jr. et al. 2003)



209



SAND PACKED COLUMNS

- Ideal flow pattern
- Uniform wetting front
- Minimal preferential edge flow
- Even depth reach inside and outside of core

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BENTONITE CLAY SLURRY

- *Laboratory Measurement of Hydraulic Conductivity of Saturated Soil*, Klute 1965
- Apply to the interface between soil core and cylinder wall
- Prevent preferential edge flow
- 1:8 grams of clay to grams of water

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POLYMER COATING

- Hydrophobic polymer coating typically applied to cars
- Goal is to keep water away from cylinder walls and promote even infiltration
- Tested 1, 2, and 3 layers: decided on 2 layers as there was no significant noticeable difference between 2 and 3 layers

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NEW SOIL PROBE

- Major inconsistencies with cores taken by different people:
  - Longer/stronger arms allow for fewer number of blows with slide hammer probe
  - Fewer blows = less disturbance = less preferential edge flow
- Built a 'hydraulic' probe:
  - Allows for even force to be consistently applied to core
  - Built using a truck jack that is powered with a drill
  - Relatively minimal disturbance to putting green

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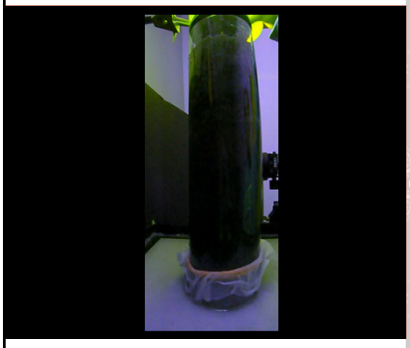

'HYDRAULIC' PROBE

Near uniform infiltration

Depth of wetting front equal inside and outside of core

Very close to desired flow

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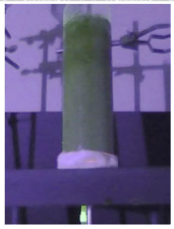
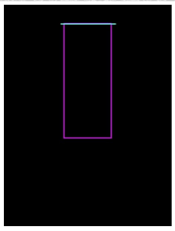
IMAGE PROCESSING WITH MATLAB





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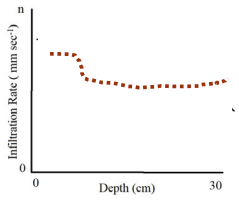
CALCULATING INFILTRATION RATE

- The position of the wetting front is a function of frame number
- Convert frame number to time (seconds)
  - Each frame is 0.0333 seconds
- Peaks indicate increase in the number of pixels saturated with dye
  - Increased downward flow of water
- Convert pixel-based metric to an absolute based metric (mm sec^{-1})
- Graph infiltration rate as it changes with depth



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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**

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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 (of some kind) is critical to increase efficiency in sand incorporation
- Solid are not different than coring tines
- Sand topdressing is essential
- Sand *then* tine
- The benefits of topdressing continue to be identified.

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Acknowledgements

USGA
EIFG Environmental Institute for Golf
Peaks & Prairies Chapter GCSAA
South Dakota Chapter GCSAA
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Nebraska Chapter GCSAA
TORO
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PlanetAir Aerate. Mow. Play.
Nebraska Turfgrass Association

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