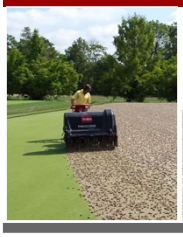
Cultivation Effects on Organic Matter Concentration and Infiltration Rates in the Golf Green Rootzone

Roch Gaussoin, Extension Turfgrass Specialist, University of Nebraska

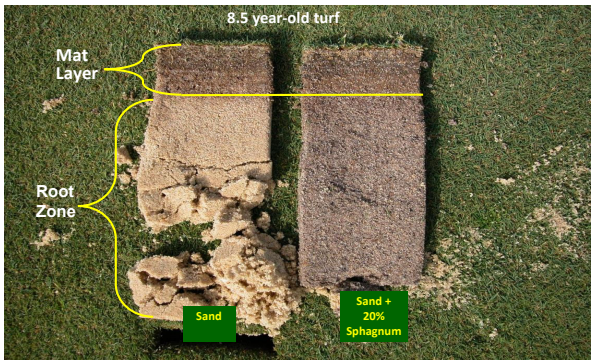


Reinders 25th Turf Conference

MARCH 9-10, 2022 - WAUKESHA EXPO CENTER

rgaussoin1@unl.edu @rockinsince57 University of Nebraska-Lincoln EXTENSION

1



2

Practices to change thatch into mat include topdressing and …

3

4

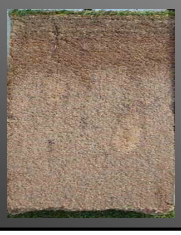
Mat

Thatch that has been intermixed with mineral (soil) matter

5

6

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).



7

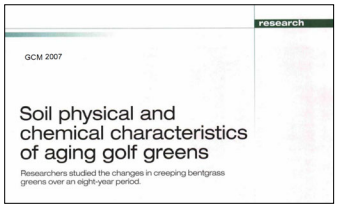
and yet one more definition……..

SOM- Soil Organic Matter

8

Where it all started

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



https://turf.unl.edu/

9

OM accumulates as sand greens age

10

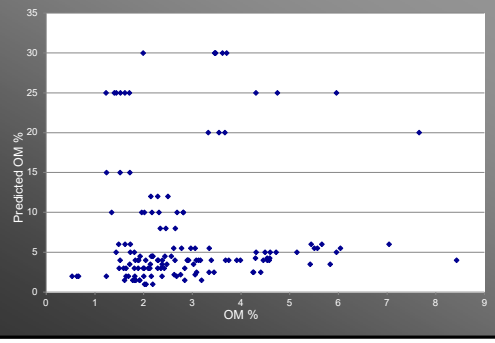
- **National Survey**
  - **Determine cause and effect relationship among management practices and their interactions relative to surface OM accumulation**

11

117 courses,
> 1600 samples

12

Range of predicted vs. actual



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Why the disconnect?

- Construction values are based on volume ratios
  - *80/20 = 8 buckets of sand: 2 buckets of organic material*
- Organic Matter is reported as a % from a lab analysis measured by weight
  - *3.5% OM X 10 = 35 grams OM/kg soil*

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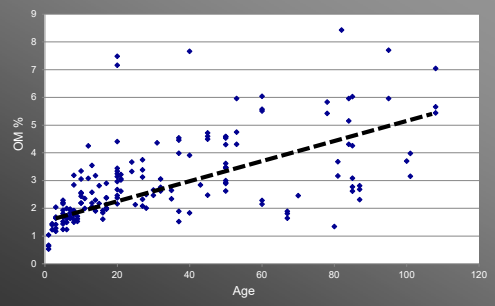
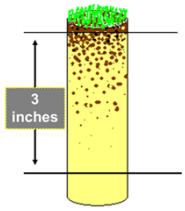
Green Age



15

Is the age effect misleading?

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



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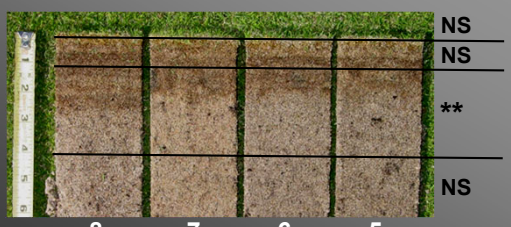
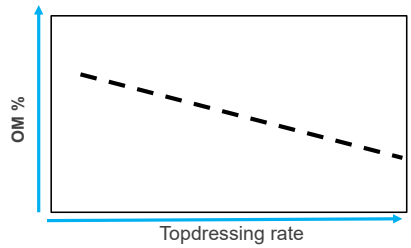
Mat Development with Age



17

Topdressing



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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" had lower OM
- Of the ***known*** cultivars, no differences in OM were evident

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

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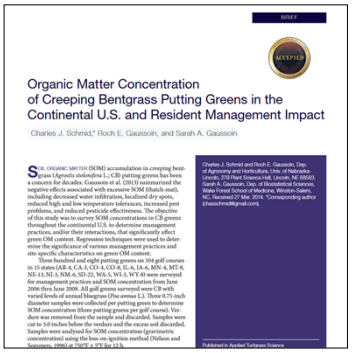

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Organic Matter Management Study

Objectives

1. Determine if conventional hollow tine is more effective than solid tine aerification at managing organic matter accumulation
2. Determine if venting methods are effective at managing OM accumulation

21

Treatments

Tine Treatment
None
2X Hollow tine
2x Solid tine

Venting Treatment
None
PlanetAir
Hydroject
Bayonet tine
Needle tine

*All **possible** combinations = 180 treatments, applied for 2 consecutive years*

22

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

Equilibrated to identify differences of the practices in question

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

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OM Data Analysis Year 2

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

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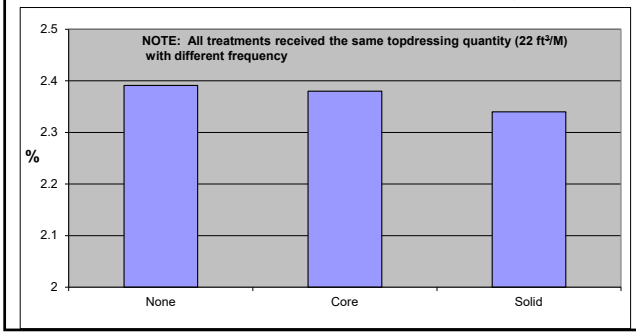
Effect of Tines on OM after 2 yrs



25

Let's take a quick look at that…

26

27

What these data do/don't suggest

- Cultivation, when topdressing quantity was equal, was insignificant in affecting OM
- Superintendents, however, must use whatever tools they have at their disposal to ensure sand is making it into the profile and not the mower buckets

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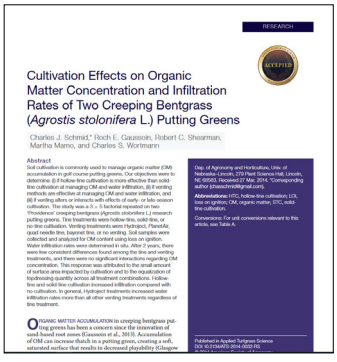
*Topdressing interval relative to Tine/Venting combinations (22 cu ft/M)**

- **NONE/NONE**
  - **5-10 days**
- **Solid & Hollow/NONE**
  - **7-14 days**
- **Solid & Hollow/Venting**
  - **14-18 days**

Observed and calculated based on displacement and surface area opened

29



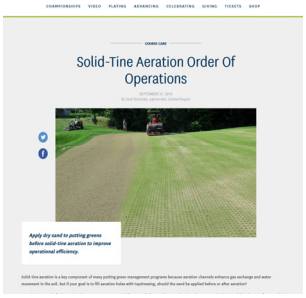
Cultivation Effects on Organic Matter Concentration and Infiltration Rates of Two Creeping Bentgrass (*Agrostis stolonifera* L.) Putting Greens

Charles J. Schmid,* Roch E. Gaussoin, Robert C. Shearman, Martha Mamo, and Charles S. Wortmann

https://turf.unl.edu/

30

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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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"

33

How do you reduce OM?

- Decomposition (microbial)
  - Increase surface area and aeration
  - Inoculation (inconsistent, not reliable)
  - Removal
  - Power raking, dethatching, core aerification
- Dilution
  - Topdressing

34

"the solution to pollution is dilution"

35

https://www.usga.org/content/usga/home-page/course-care/green-section-record/57/9/light-and-frequent-topdressing-programs.html

36

37

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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"Growth Potential"

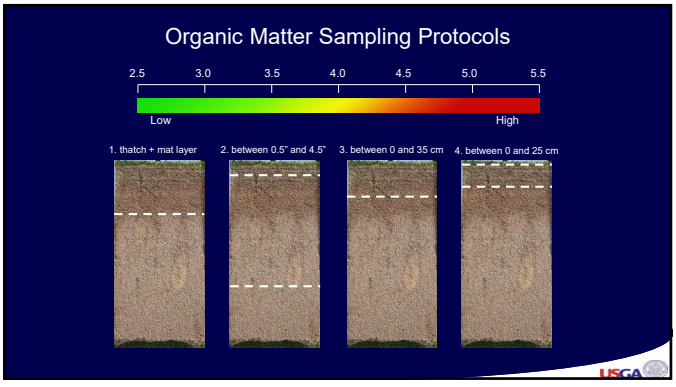
- Pace Turf
  - –https://www.paceturf.org/public/sand-and-growth-potential

39

#clipvol "*One bucket at a time*"

- Micah Woods, Asian Turfgrass Center
  - Asianturfgrass.com

40



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International Sports Turf Research Center

ISTRC SYSTEM

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Sample Report (portion)

Organic Content –¼ to 1"	1.82% [ok – for the age of the greens the cultural program has done an excellent job keeping up with the plant-deposited OM & thatch]	1.5% to 2.5%
Organic Content – 1 to 2"	0.99% [ok]	1.0% to 2.0%
Organic Content – 2 to 3"	0.89% [ok]	0.5% to 2.0%
Organic Content – 3 to 4"	0.47% [ok]	0.5% to 1.5%

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#OM246 (#OM123) Putting Green Organic Matter by Depth

- Micah Woods, Asian Turfgrass Center

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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

An empirical model to predict OM fate in putting green rootzones

https://buckeyeturf.osu.edu/organicmattertool

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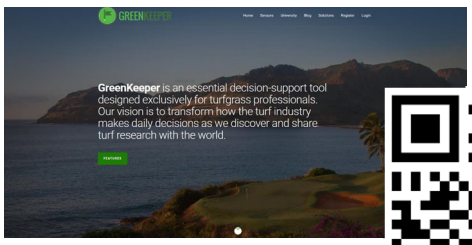
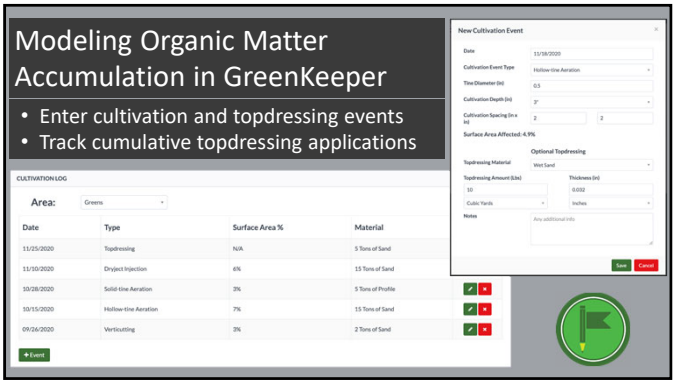


https://www.greenkeeperapp.com/marketing/

46

Modeling Organic Matter Accumulation in GreenKeeper

- Enter cultivation and topdressing events
- Track cumulative topdressing applications



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"the solution to pollution is ~~dilution~~ decomposition"

48

Dilution vs decomposition

49

Organic constituent composition changes with decomposition "OM quality"

lignin content ⬆ with depth
(Couillard and Turgeon, 1997)

…also likely to be finer particulates, less soluble, semi-stable, and others that affect quality

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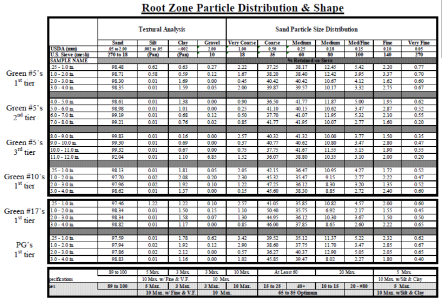
Sample Report



Root Zone Particle Distribution & Shape

		Textural Analysis				Sand Particle Size Distribution						
		Sand	Silt	Clay	Gravel	Very Coarse	Coarse	Medium	Medium	Med/Fine	Fine	Very Fine
	USDA (mm)	.05 to 2.00	.002 to .05	<.002	2.00	1.00	0.50	0.25	0.18	0.15	0.10	0.05
	U.S. Sieve (mesh)	270 to 18	(Pan)	(Pan)	10	18	35	60	80	100	140	270
	SAMPLE NAME					% Retained on Sieve						
Green #5's 1st tier	.25 - 1.0 in.	98.48	0.62	0.63	0.27	2.22	37.25	38.17	12.45	5.42	2.20	0.77
	1.0 - 2.0 in.	98.71	0.58	0.59	0.12	1.67	38.20	38.40	12.42	3.95	3.37	0.70
	2.0 - 3.0 in.	98.30	0.01	1.69	0.00	0.45	40.42	40.42	10.67	4.12	1.62	0.60
	3.0 - 4.0 in.	98.35	0.01	1.59	0.05	2.00	39.87	39.57	10.17	3.32	2.75	0.67
Green #5's 2nd tier	4.0 - 5.0 in.	98.61	0.01	1.38	0.00	0.90	36.50	41.77	11.87	5.00	1.95	0.62
	5.0 - 6.0 in.	98.98	0.01	1.01	0.00	0.25	41.10	40.15	10.62	3.47	2.87	0.52
	6.0 - 7.0 in.	99.19	0.01	0.68	0.12	0.50	37.70	41.07	11.95	5.32	2.10	0.55
	7.0 - 8.0 in.	99.21	0.01	0.76	0.02	0.85	41.77	41.95	10.07	2.77	1.60	0.20
Green #5's 3rd tier	8.0 - 9.0 in.	99.83	0.01	0.16	0.00	2.57	40.32	41.32	10.00	3.77	1.50	0.35
	9.0 - 10.0 in.	99.30	0.01	0.69	0.00	0.37	40.77	40.62	10.80	3.47	2.80	0.47
	10.0 - 11.0 in.	99.32	0.01	0.67	0.00	0.75	37.75	41.67	11.55	5.15	1.90	0.55
	11.0 - 12.0 in.	92.04	0.01	1.10	6.85	1.52	36.07	38.80	10.35	3.10	2.00	0.20
Green #10's 1st tier	.25 - 1.0 in.	98.13	0.01	1.81	0.05	2.05	42.15	36.47	10.95	4.27	1.72	0.52
	1.0 - 2.0 in.	97.70	0.02	2.08	0.20	2.30	45.32	35.47	9.15	2.77	2.22	0.47
	2.0 - 3.0 in.	97.96	0.02	1.92	0.10	1.22	47.25	36.12	8.30	3.20	1.35	0.52
	3.0 - 4.0 in.	98.62	0.01	1.37	0.00	0.15	45.60	38.30	8.85	2.72	2.40	0.60
Green #17's 1st tier	.25 - 1.0 in.	97.46	1.22	1.22	0.10	2.57	41.05	35.85	10.82	4.57	2.00	0.60
	1.0 - 2.0 in.	98.34	0.01	1.50	0.15	1.10	50.40	35.75	6.92	2.17	1.55	0.45
	2.0 - 3.0 in.	98.34	0.01	1.58	0.07	1.30	44.95	36.12	10.30	3.67	1.50	0.50
	3.0 - 4.0 in.	98.82	0.01	1.17	0.00	0.85	46.00	37.85	8.65	2.60	2.22	0.65
PG's 1st tier	.25 - 1.0 in.	97.59	0.01	1.78	0.62	3.42	39.52	35.12	11.37	5.22	2.32	0.62
	1.0 - 2.0 in.	97.94	0.02	1.92	0.12	2.90	38.60	37.75	11.70	3.47	2.85	0.67
	2.0 - 3.0 in.	97.86	0.02	2.12	0.00	0.57	36.27	40.37	12.90	5.05	2.05	0.65
	3.0 - 4.0 in.	98.83	0.01	1.16	0.00	1.02	45.85	39.47	8.02	2.27	1.80	0.40
		89 to 100	5 Max.	3 Max.	3 Max.	10 Max.	At Least 60		20 Max.		5 Max.	
	pecifications		10 Max. w/ Fine & V.F.		10 Max.						10 Max. w/Silt & Clay	
	es	89 to 100	5 Max.	3 Max.	3 Max.	10 Max.	15 to 25	40+	10 to 15	20 - #80	5 Max.	
			10 Max. w/ Fine & V.F.		10 Max.		65 to 85 Optimum				10 Max. w/Silt & Clay	

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

- One size does not fit all
- The universal optimal % OM has not been scientifically determined and may be mythical
- Methodology & sampling differences exist and must be considered
  - *Help is on the horizon (USGA OM Brain Trust)*
- Cultivation is critical to increase efficiency in sand incorporation
- Solid are not different than coring tines
- The benefits of topdressing continue to be identified.
  - Sand size does matter

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Sand Particle Size (1- and 0.5-mm sands)

Particle Name	Diameter (mm)
Fine Gravel	2 – 3.4
Very Coarse Sand	1 – 2
Coarse Sand	0.5 – 1
Medium Sand	0.25 – 0.5
Fine Sand	0.15 – 0.25
Very Fine Sand	0.05 – 0.15
Silt	0.002 – 0.05
Clay	< 0.002

Photo: TJ Lawson

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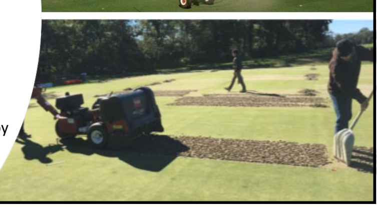
Managing for Drier Mat

JA Murphy Rutgers Univ

- Topdress as much and as often as feasible
- Especially important if cultivation is minimal
- Select as coarse a sand as feasible
  - 1.0-mm (coarse) difficult to incorporate
  - 0.5-mm sand okay if dominated by medium, not fine and very fine
- Cost and interference are limiting factors



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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%

J. W. Murphy: < 4.5%

Adams: < 5%

N.Z. Turf In.: < 8%

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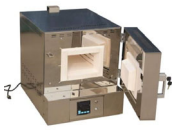
How is it normally done at a lab?

Loss on Ignition (LOI)



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

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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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Need to have a sand-based root zone specific sampling and analysis protocol

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Developing a Standard for Measuring Organic Matter in Putting Green Soils

- Collaborators:
  - Roch Gaussoin / Professor / Agronomy & Horticulture/University of Nebraska-Lincoln
  - Doug Linde / Professor / Plant Science / Delaware Valley University
  - James Murphy / Professor / Plant Biology / Rutgers University
  - Doug Soldat / Professor / Soil Science / University of Wisconsin-Madison

Funded by the USGA

USGA

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Findings to date…..

- small diameter samples (0.75” or 1.5”) can be useful for accurately determining organic matter; samples should no less than ~10 feet apart.

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Next steps

- Verdure on or off?
- How does sample preparation (grinding and sieving) affect variation of soil organic matter?
- How does soil organic matter vary within and across putting greens within the same property?
- What is the optimal number of samples required to balance accuracy with practicality?

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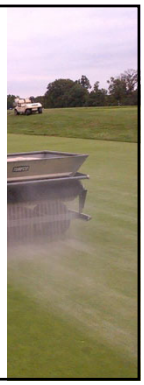
“the solution to pollution is dilution”



63

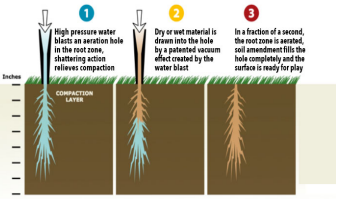
What these data do/don’t suggest

- Cultivation, when topdressing quantity was equal, was insignificant in affecting OM
- Superintendents, however, must use ***whatever tools*** they have at their disposal to ensure sand is making it into the profile and not the mower buckets

64

65

DryJect



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Dryject Trial Fall 2021

- Check
- Hollow ½" ID
- Solid ½"OD
- DryJect 1 (3x3)
- Needle
- DryJect 2 (3x2)
- Needle + Solid
- Needle + Hollow

Procore - 3" target depth on all tines except Dryject = 5"

Sampled day after treatment in 1' depth increments to 4 "

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Treatment	% OM	
Check	4.5	a
Hollow	3.7	b
Needle	3.1	c
DryJect (3x3)	2.7	d
Needle + Hollow	2.3	d
DryJect (3x2)	2.3	d
Needle + Solid	2.3	d
Solid	2.2	d

- No differences among depths
- Dilution only
- Dryject and needle tine were least surface disruptive
- Hollow tine response was unexpected
- ***Data is preliminary***

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Chapter 12 ASA Monograph (3RD Edition)

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

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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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Acknowledgements

- Nebraska Turfgrass Association
- USGA
- Environmental Institute for Golf
- Nebraska GCSA
- GCSA of South Dakota
- Peaks & Prairies GCSA
- Jacobsen, Toro, JRM, PlanetAir & DryJect

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