It's about tine(s), a closer look at putting green aeration and sand incorporation

Kentuckiana Chapter GCSAA
Golf Course Superintendents Association of America

Annual Membership Meeting Golf Event & Turf Expo
Chariot Run Golf Club & Caesars Southern Indiana
October 14 & 15, 2024

Roch Gaussoin, Emeritus Professor, University of Nebraska
N EXTENSION

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Research Need (2004)

- Comprehensive evaluation of sand quantity, particle size, sampling protocol and cultivation methods

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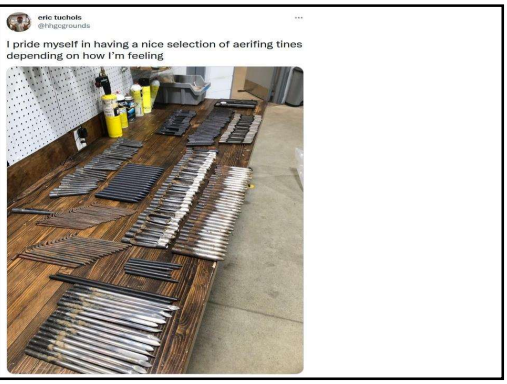

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Tine Trial Fall 2021

- Check
- Hollow ½" ID
- Solid ½"OD
- DryJect (3x3)
- ¼" Solid (Needle)
- DryJect (3x2)
- Needle + Solid
- Needle + Hollow

Procore 648 - 3" target depth on all tines
Dryject = 5"

Sampled for OM the day after
Treatment in 1' depth increments to 4 "

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Treatment	% OM 0-4"	
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
- ***Data is preliminary***

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Spring 2023 Tine Trial

- ~~9~~ 28 tine types/configurations including Viper tines
- 2 devices (ProCore 648 and DryJect)
- Timing (spring/fall)
- Topdressing before or after
- Data
  - OM
  - Surface parameters using the USGA GS3
  - Other data

Equipment and Tine Support Provided by

TORO CTI Ceres Turf, Inc. DryJect WET Heartland Golf & Turf Services LLC

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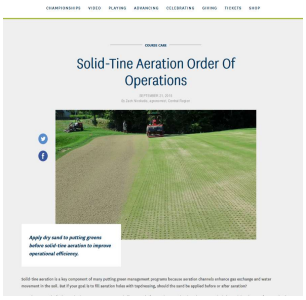
https://www.usga.org/content/usga/home-page/course-care/regional-updates/central-region/2018/solid-tine-aeration-order-of-operations.html



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Treatments (Spring, FB Oct 3 except DryJect on Oct 16)

- Main Plots (42' X 60' with a 6' border between)
  - 1. Topdress before tines with 0.25"(0.125" on October 2023) on surface (equates to 1 (1/2 fall) ton/1000 ft^2 or 20 ft^3/1000ft^2)
  - 2. Topdress after tines
- Sub-plots (tine treatments) set at 3" depth
  - ***1. 5/8' Viper Nose™***
  - ***2. 1/2" Viper Nose™***
  - 3. 3/8" solid
  - ***4.*** ½" solid cross
  - 5. Untined control
  - 6. ¼ " solid
  - 7. .50" solid
  - ***8. 3/8" hollow, side eject***
  - 9. 1/2" solid cross
  - 10. .75" solid slicing
  - **11. 1/2" hollow, tapered**
  - **12. 1/2" hollow side eject**
  - **13. DryJect 3X3**
  - 14. Untined Control
  - 15. **DryJect 2X3**

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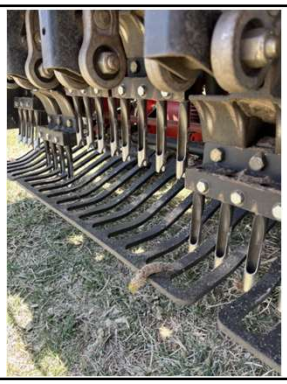


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Plot after dragging and several mowings and irrigation


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Data Collection

- Organic matter, 3-5 days after treatment directly over aeration hole
- Infiltration approx. weekly
- NDVI (cover measured digitally) every few days
- Firmness
- Surface Moisture TDR 0-3'; 3-6"
- GS3
  - –Ball roll
  - –Smoothness
  - –Trueness

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Fall 2023 Data Results (<.05 = statistical difference)

ANOVA	10-Oct	18-Oct	21-Oct	26-Oct		9-Oct	16-Oct	25-Oct
Effect	NDVI-1	NDVI-2	NDVI-3	NDVI-4	%OM	Infil-1	Infil-2	Infil-3
Topdressing (TD)	0.1161	0.5583	0.6987	0.2785	**0.0466**	0.3444	0.188	0.1061
Tine TRT	**<.0001**	**0.0049**	**0.0353**	0.114	**<.0001**	**<.0001**	**<.0001**	**<.0001**
TD*TRT	0.0761	0.925	0.2796	0.1175	**0.0107**	0.1	**0.0076**	0.4673

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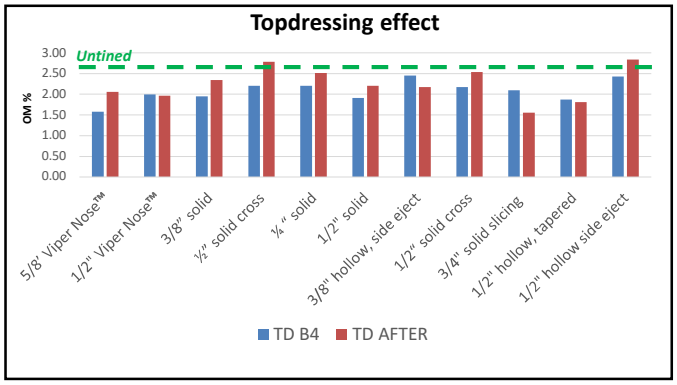

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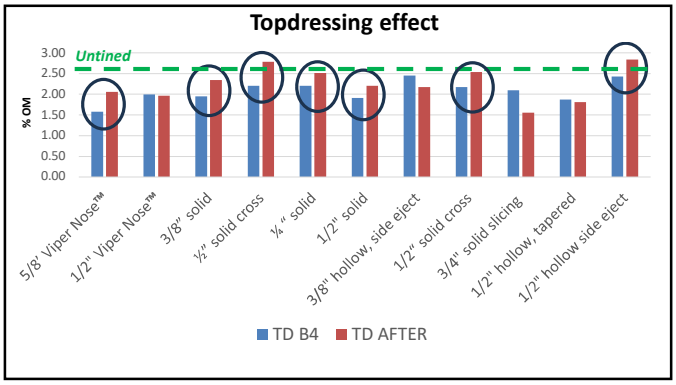

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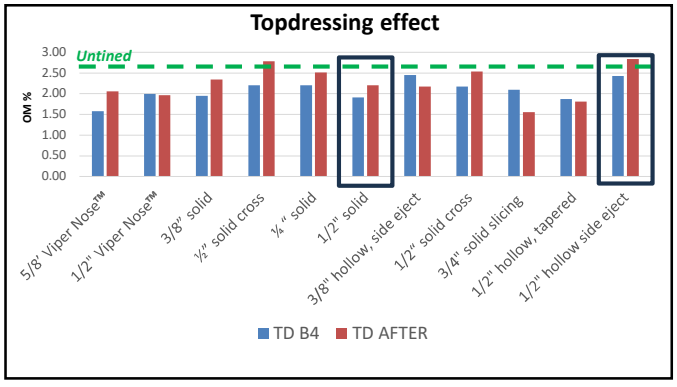

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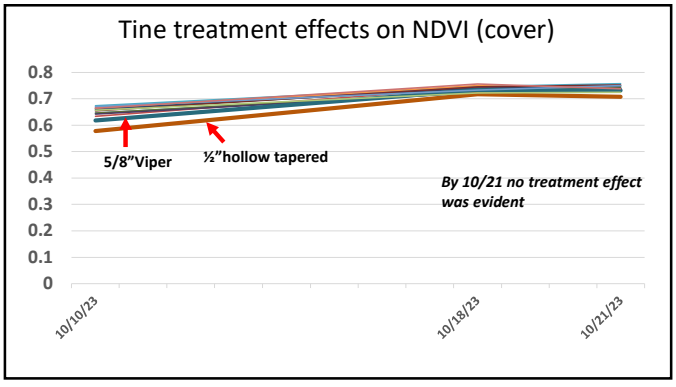

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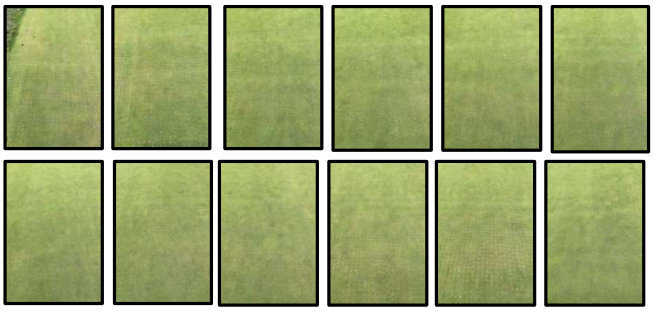
All treatments-October 21



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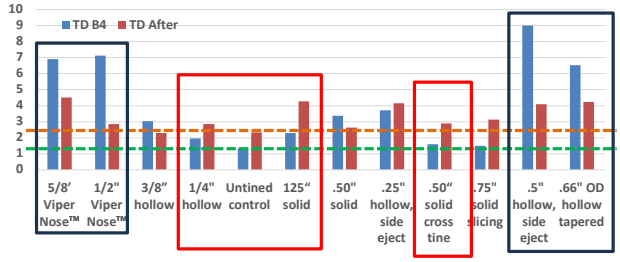
Tine/TD effects on Infiltration (inches per hr)
2.5 weeks post aeration



Positive effect on infiltration was greater for ½" or larger hollow tine & TD before aeration

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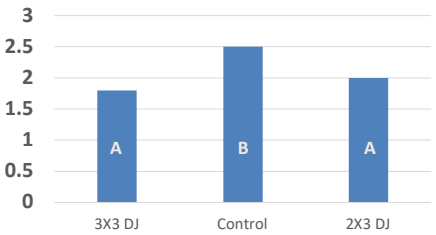
DryJect OM %*



*No topdressing effect; numerically equivalent to most other tine treatments

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Fall 2023 GS3 Data Results (<.05 = statistical difference)

Ball Roll 1 WAT		
Effect	**F Value**	**Pr > F**
TD	**5.5**	**0.1437**
TRT	**4.44**	**<.0001**
TRT*TD	**2.85**	**0.0027**

TD before aerification increased ball roll more for ½" or greater hollow tines than same diameter solid tines. Solid tines had higher ball roll than equivalent hollow tines. Effects were less evident 2 WAT.

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Fall 2023 GS3 Data Results (<.05 = statistical difference)

Trueness 1 WAT		
Effect	**F Value**	**Pr > F**
TD	**0.16**	**0.7316**
TRT	**1**	**0.4689**
TRT*TD	**0.66**	**0.8037**

Smoothness 1 WAT		
Effect	**F Value**	**Pr > F**
TD	**0.33**	**0.6245**
TRT	**0.64**	**0.8234**
TRT*TD	**0.83**	**0.636**

Results were similar and NS 2 & 3 WAT

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Treatments would appear to be visually different and when data were captured ball deviations appeared evident. Visual STRI Smoothness data were not collected.

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Deeper Dive Into Data

Confounding data due to excessive enthusiasm of researcher

Different statistical approach to isolate specific factors of interest

Orthogonal comparisons

This approach successfully separated out differences not evident from traditional ANOVA analysis for other data. GS3 data still needs to be investigated.

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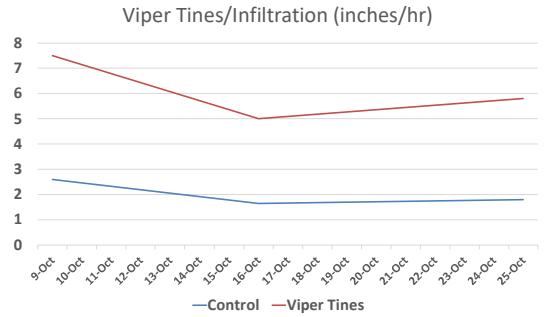

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1/2 Solid	1/2 Hollow
% OM	
1.8	2.4

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Oct-25 Infiltration	
1/2 Solid	1/2 Hollow
Inch/hr	
2.8	6.6

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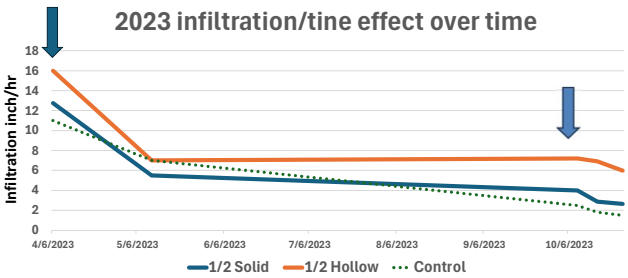

Prior to study, area was aerated with ½" solid tines 2X/yr and topdressed with medium-fine sand for 5 years. Initial infiltration in 2018 was 12"/hr.

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Early Results

- Lots of stuff going on
- Topdressing before aeration, even with *some* hollow tines will incorporate more sand
- Higher and prolonged infiltration greater for hollow tines ½" or larger than any solid tines
- Viper tines had greatest increase in infiltration over time than any other tine
- ***Uninterrupted use of solid tines needs to be rethought***
- Study will continue into 2024…….maybe longer

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Spring 2024 Results

- Cumulative effect of 3 cultivation events
- Similar outcomes to Fall 2023
- "Better" GS3 data

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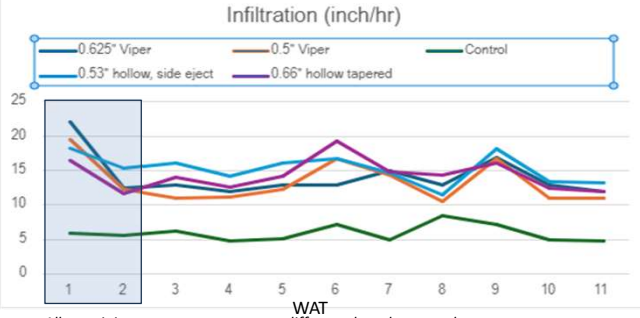

All remaining treatments were not different than the control within 2 weeks

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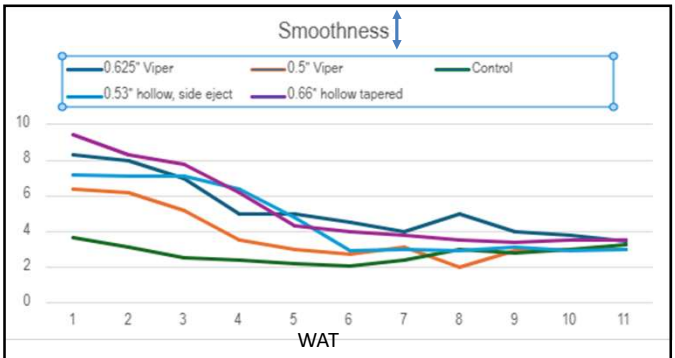

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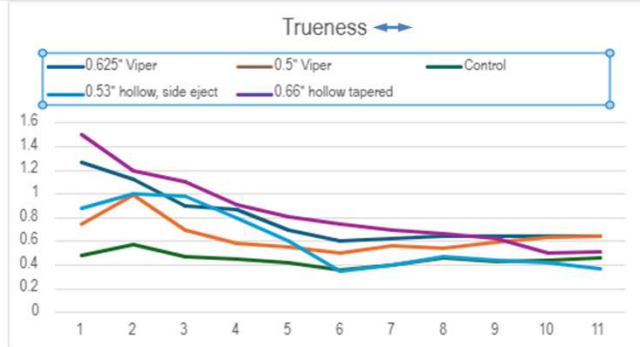

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PROCORE 648 VS 648S: Is there a difference in tine displacement and sand reception?

EXTENSION

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Fall 2023

- Is there a difference in solid tine displacement and sand reception?

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Champions Run, Omaha, NE

Aerated on separate areas of the sand-based nursery putting green at 0.125" HOC, with ½" solid tines set at 3" with a 648S and 648. Each area was 60 ft².

Sampled for OM with a 1" probe above aeration hole; 0-3" and 3-6" with 10 random locations per aerator. By extension, lower OM soon after aerification = greater sand incorporation.

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Results

	648	648S
OM % 0-3"	2.2a	1.6b
OM % 3-6"	1.6a	1.4a

Different letters within a row indicate statistically significant differences at P < .01 based on a paired t-test with 18df

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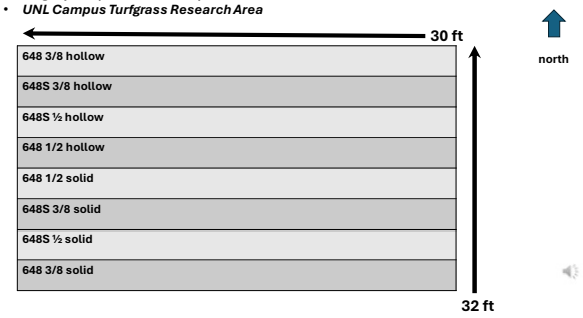
ProCore 648 vs 648S *Spring 2024*

- ***Single pass (48" wide E to W)***
- ***UNL Campus Turfgrass Research Area***



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Aerators (set to identical configurations)

- **648S**
  - Champions Club, Omaha, NE
  - 72.5 hours
  - 3" depth
  - Thanks to Superintendent Greg Jones for loan
- **648**
  - Happy Hollow Club, Omaha, NE
  - 17.7 hours
  - 3" depth
  - Thanks to Superintendent Peter Schmidt for loan

Thanks to Dan Parr, Midwest Turf & Irrigation for aerator transport and assistance.

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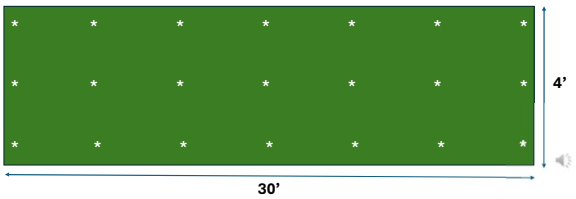
Sampling Locations

Sampled for OM with a 1" probe above aeration hole; 0-3" with 21 locations per plot.
By extension, lower OM soon after aerification = greater sand incorporation.



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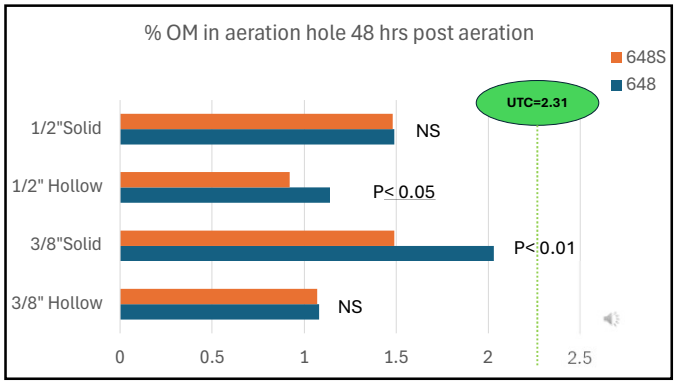

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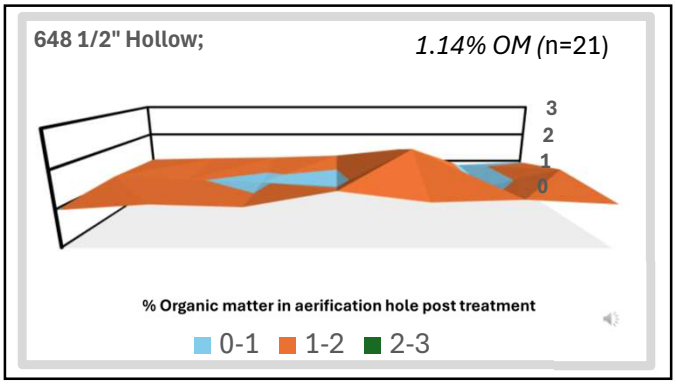

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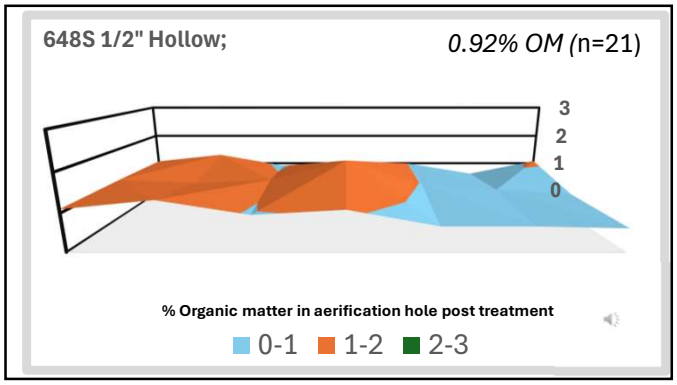

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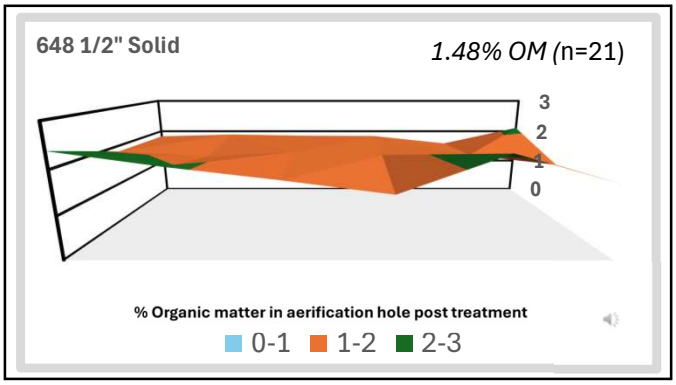

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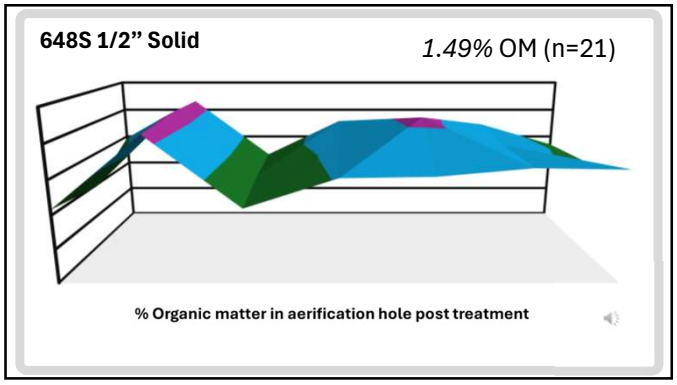

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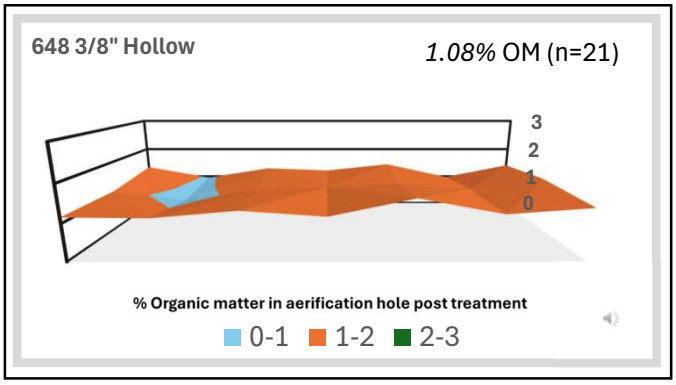

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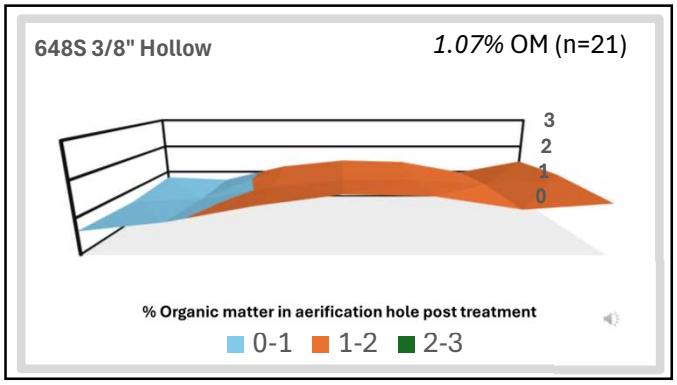

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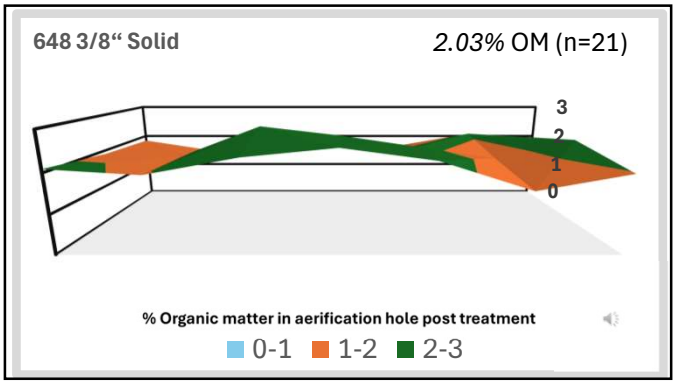

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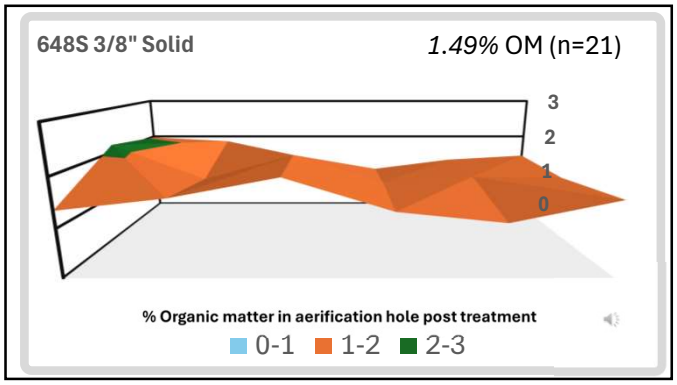

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Acknowledgements

- USGA
- Environmental Institute for Golf
- Nebraska GCSA
- GCSA of South Dakota
- Peaks & Prairies GCSA
- Toro, DryJect, Ceres Turf, Inc
- Nebraska Turfgrass Association

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Contact Information

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Thank you!

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