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# Harmonizing growth, organic material, and surface performance: warm-season grass edition

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Micah Woods, Ph.D.

February 3, 2026

Asian Turfgrass Center  
[www.asianturfgrass.com](http://www.asianturfgrass.com)

PACE Turf  
[www.paceturf.org](http://www.paceturf.org)



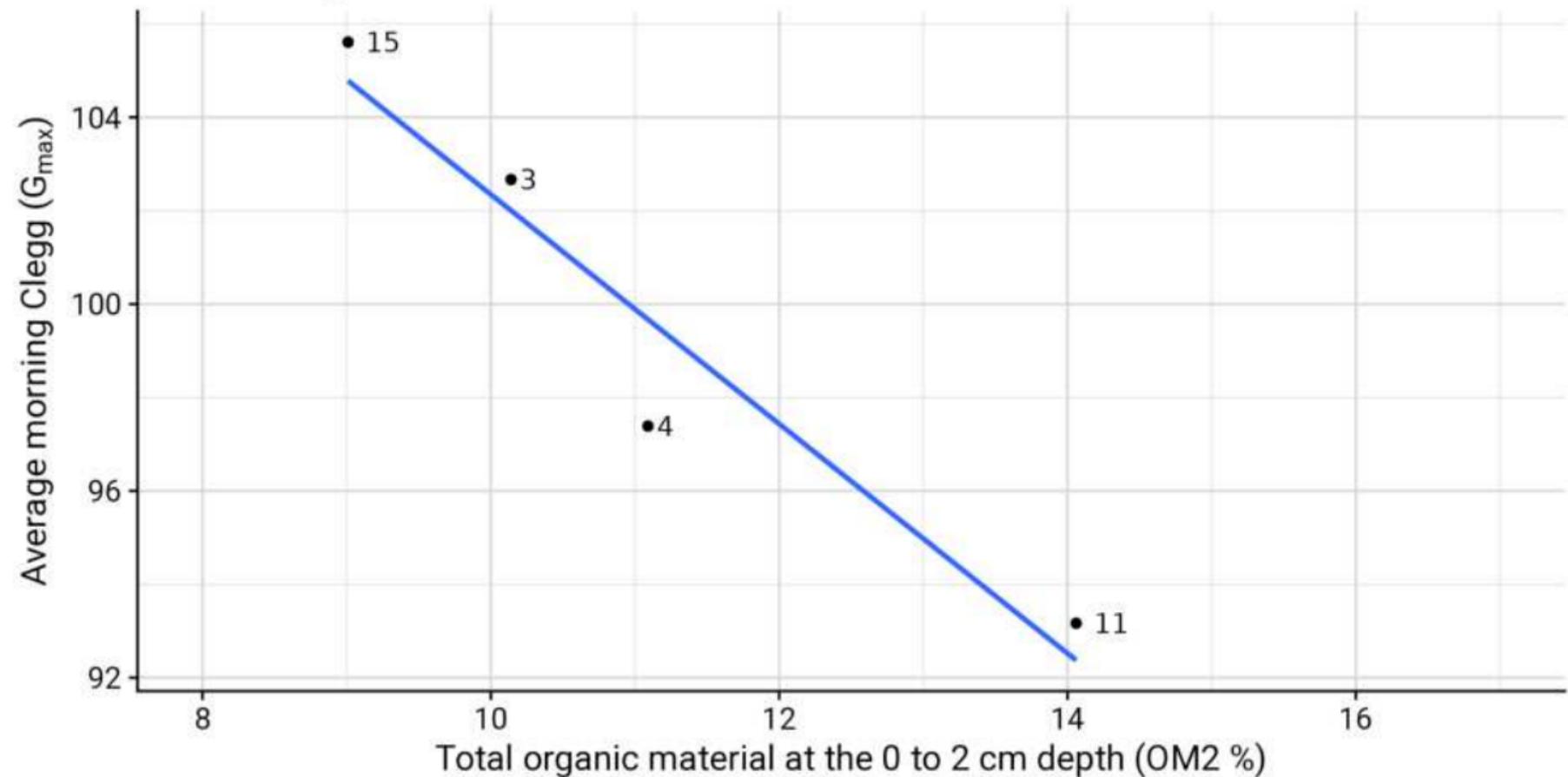


**sansan** KBC AUGUSTA  
GOLF TOURNAMENT

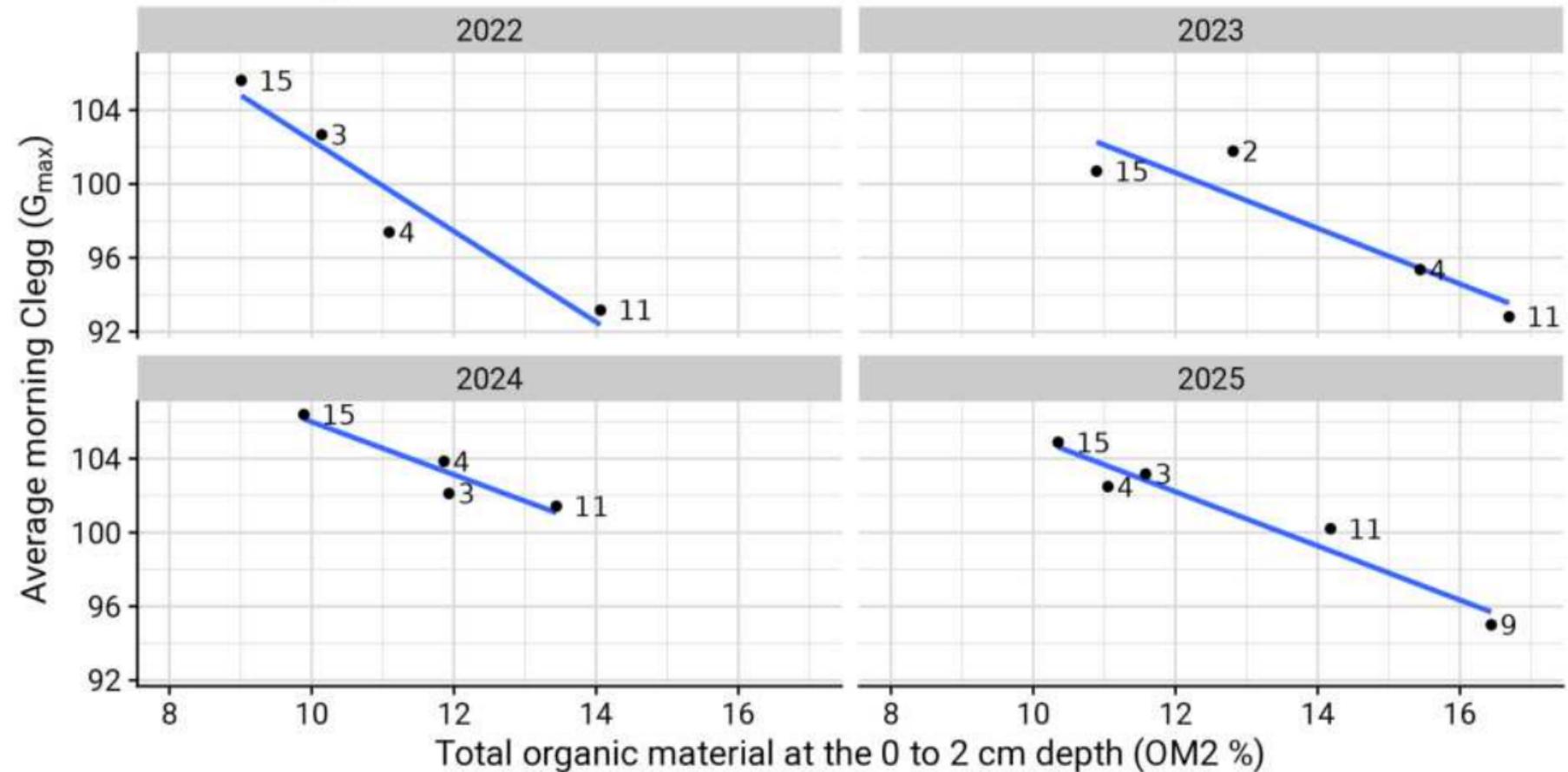
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# Individual green OM2 vs. tournament week firmness

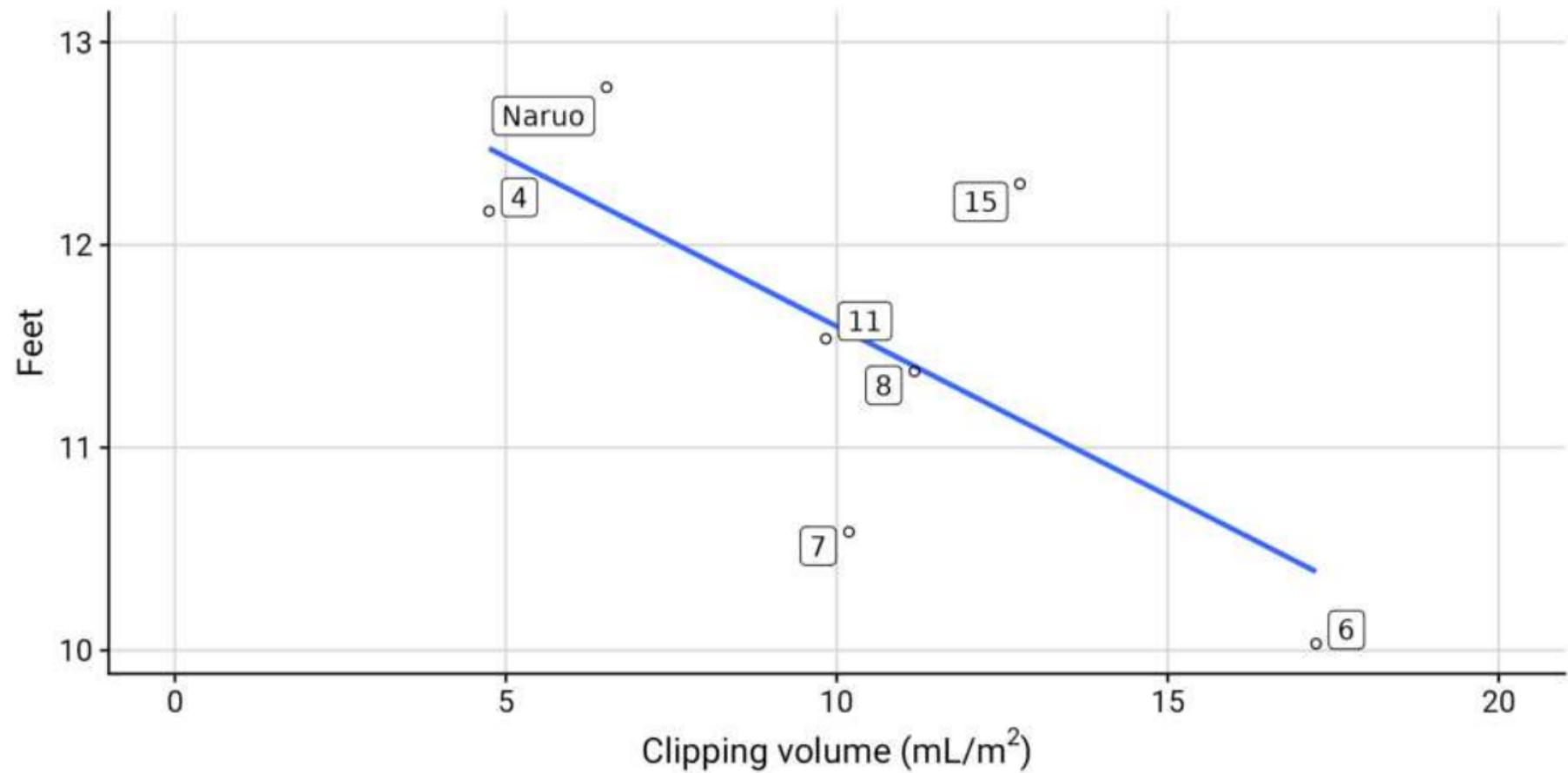


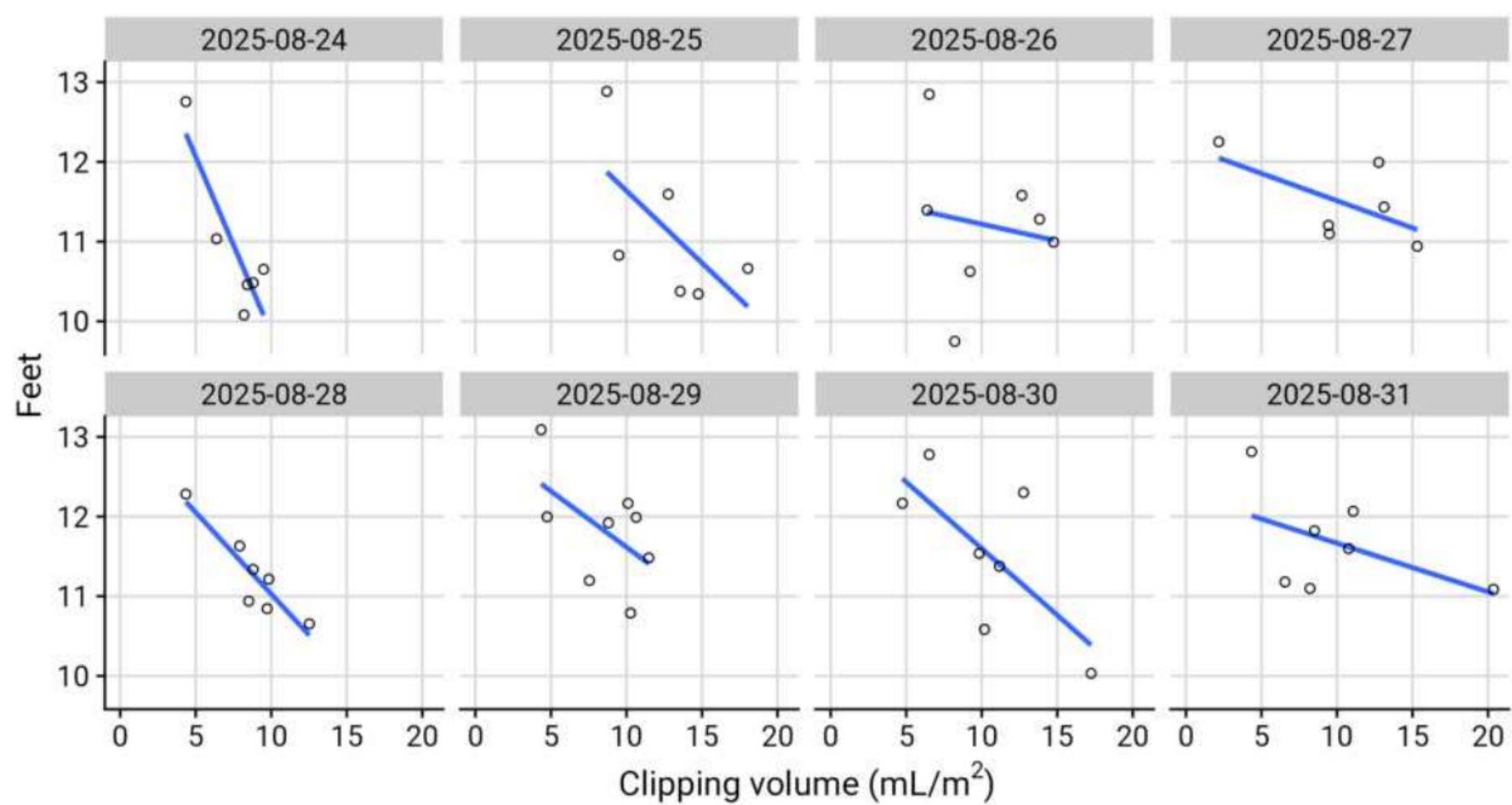
# Individual green OM2 vs. tournament week firmness





2025-08-30





# Our afternoon outline

- Growth rate (clipping volume)
- Soil organic material (OM246)
- Nutrient supply (MLSN)
- Playing conditions
- Harmonization (Turf GvX)

# Growth rate

---

# Machine and cutting unit setup and clipvol variation





Photo by Tako Miyamoto







Video time stamp: 1 second



Video time stamp: 4 seconds



Video time stamp: 10 seconds











I estimate 1 L of fresh clippings, when dried, will have a mass of **63 g**.

Or, 1 gallon of fresh clippings, when dried, will have a mass of about **0.53 pounds**.

For *Zoysia*, I estimate 1 L of fresh clippings, when dried, will have a mass of **110 g**.

Or, 1 gallon of fresh clippings, when dried, will have a mass of about **0.92 pounds**.



# Normal nutrient content of bermudagrass leaves

Element	Concentration (%)		
	10 <sup>th</sup> percentile	Median	90 <sup>th</sup> percentile
N	2.7	3.9	5.2
P	0.23	0.40	0.57
K	0.85	1.4	1.9
Ca	0.14	0.32	0.49
Mg	0.11	0.17	0.23
S	0.24	0.40	0.54

# Normal nutrient content of seashore paspalum leaves

Element	Concentration (%)		
	10 <sup>th</sup> percentile	Median	90 <sup>th</sup> percentile
N	1.9	3.3	4.6
P	0.15	0.35	0.52
K	1.5	2.1	2.7
Ca	0.07	0.27	0.45
Mg	0.12	0.18	0.24
S	0.53	0.71	0.88

## Normal nutrient content of *Zoysia matrella* leaves

Element	Concentration (%)		
	10 <sup>th</sup> percentile	Median	90 <sup>th</sup> percentile
N	0.98	2.3	3.5
P	0.11	0.27	0.44
K	0.49	1.0	1.6
Ca	0.06	0.24	0.41
Mg	0.05	0.11	0.17
S	0.14	0.29	0.44



# Cumulative clipping volume

As an example: Tifeagle greens near Bangkok

2023 3.8 L/m<sup>2</sup>

2024 3.8 L/m<sup>2</sup>

2025 4 L/m<sup>2</sup>

# Organizing ClipVol data

date 1 | time | 1 | 2 | 3 | 4 | 5 | 6 | ... | 18 | avg | sd | notes

date 2 ...

date 3 ...

...

Last mow

# One Bucket at a Time

A guide to rapid measurement of clipping volume with various permutations, applications, and implications

Micah Woods

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# Maintenance Maturity Model

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1. Reactive
2. Preventative
3. Condition-based
4. Predictive/prescriptive

# Soil Organic Material

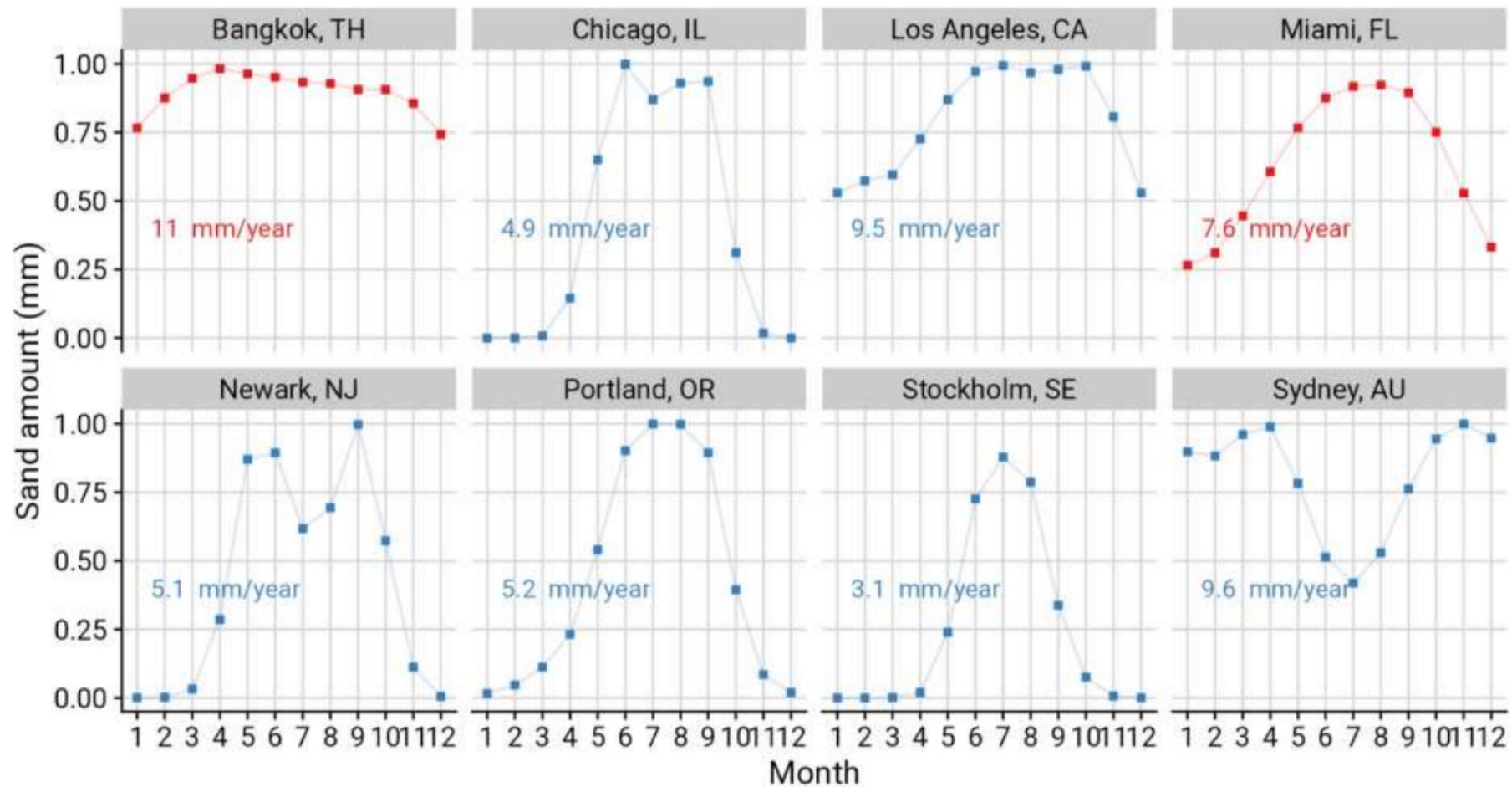
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Know the sand application rate

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# Temperature-based growth potential prediction of sand topdressing



1 mm  $\approx$  320 lbs/1,000 ft<sup>2</sup>

1 mm  $\approx$  3.3 ft<sup>3</sup>/1,000 ft<sup>2</sup>

1 mm  $\approx$  16 tons/ha

Measure total organic material  
(OM246)

---



0 to 0.8  
inches

0.8 to 1.6  
inches

1.6 to 2.4  
inches

0 to 2 cm  
OM2

2 to 4 cm  
OM4

4 to 6 cm  
OM6



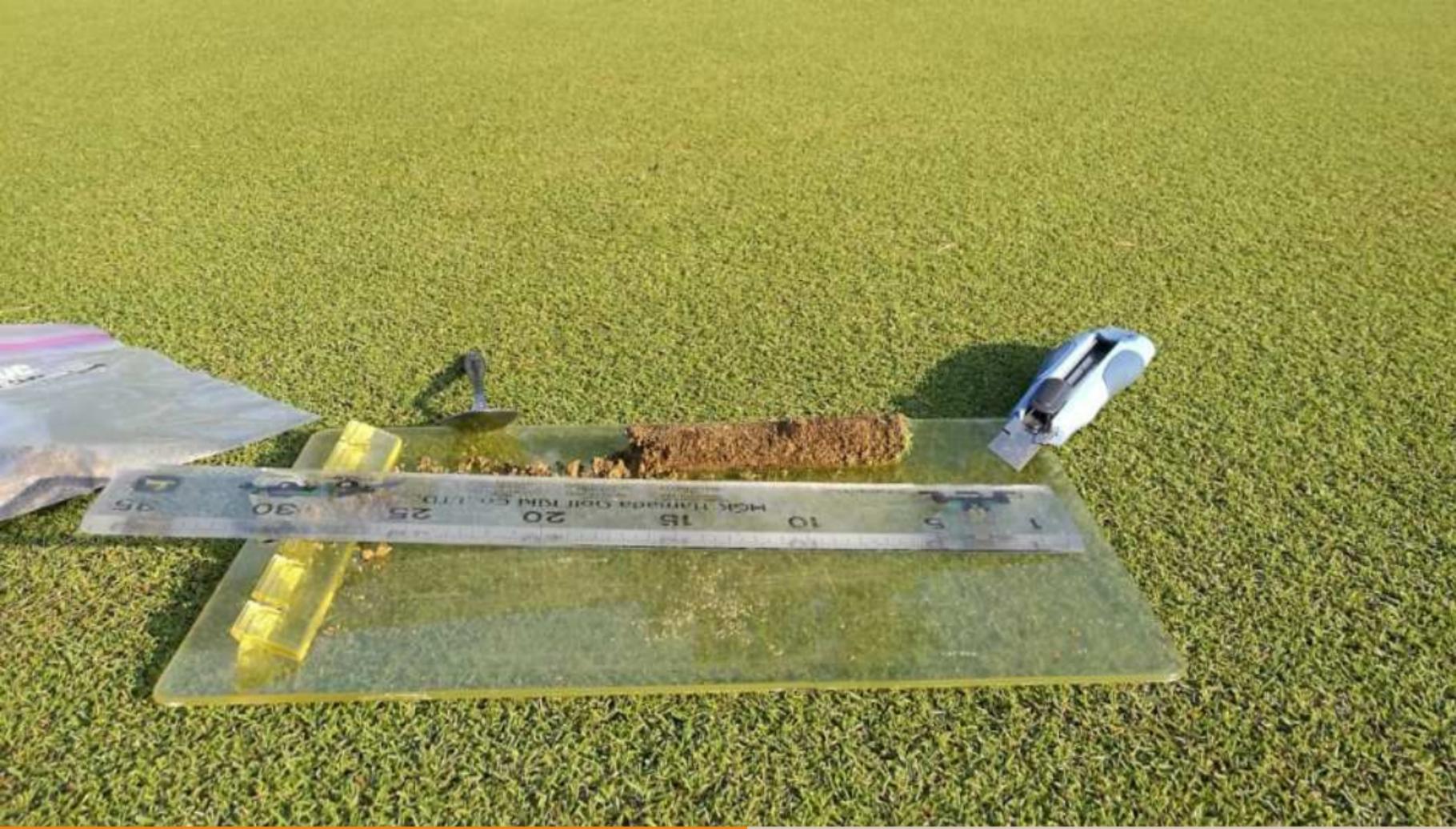
# The definition of soil organic matter

**soil organic matter:** The organic fraction of the soil exclusive of undecayed plant and animal residues. See also humus.

**humus:** the well decomposed, more or less stable part of the organic matter in mineral soils.

# Total organic material

**total organic material:** organic material in a soil sample that has not passed through a sieve. This test is conducted on the sample as it is received at the laboratory, with no removal of living or dead plant material prior to testing.



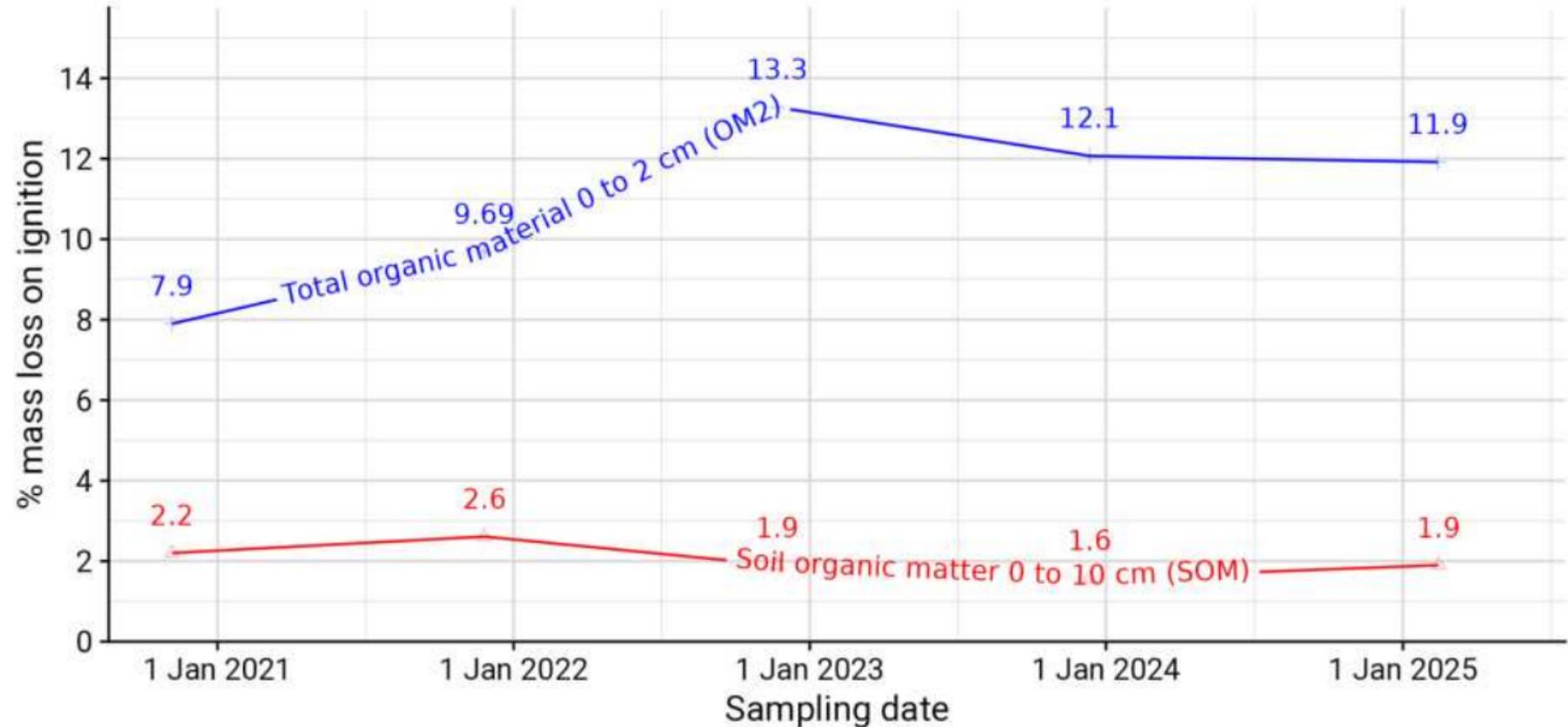






# Tifeagle putting greens

samples from Bangsai CC



All soil tests conducted at Brookside Labs

**Depth of soil layer (cm)****Starting OM %****Ending OM %****Date range (starting OM% & ending OM%)**

to

**Sand added (mm)**

If you have applied 4 mm of sand to a 2 cm layer of the rootzone with a starting OM of 8% on 2024-02-03 and ending OM of 8% on 2025-02-03, the total organic material accumulation rate is:

**21.62 grams per kg of soil per year**



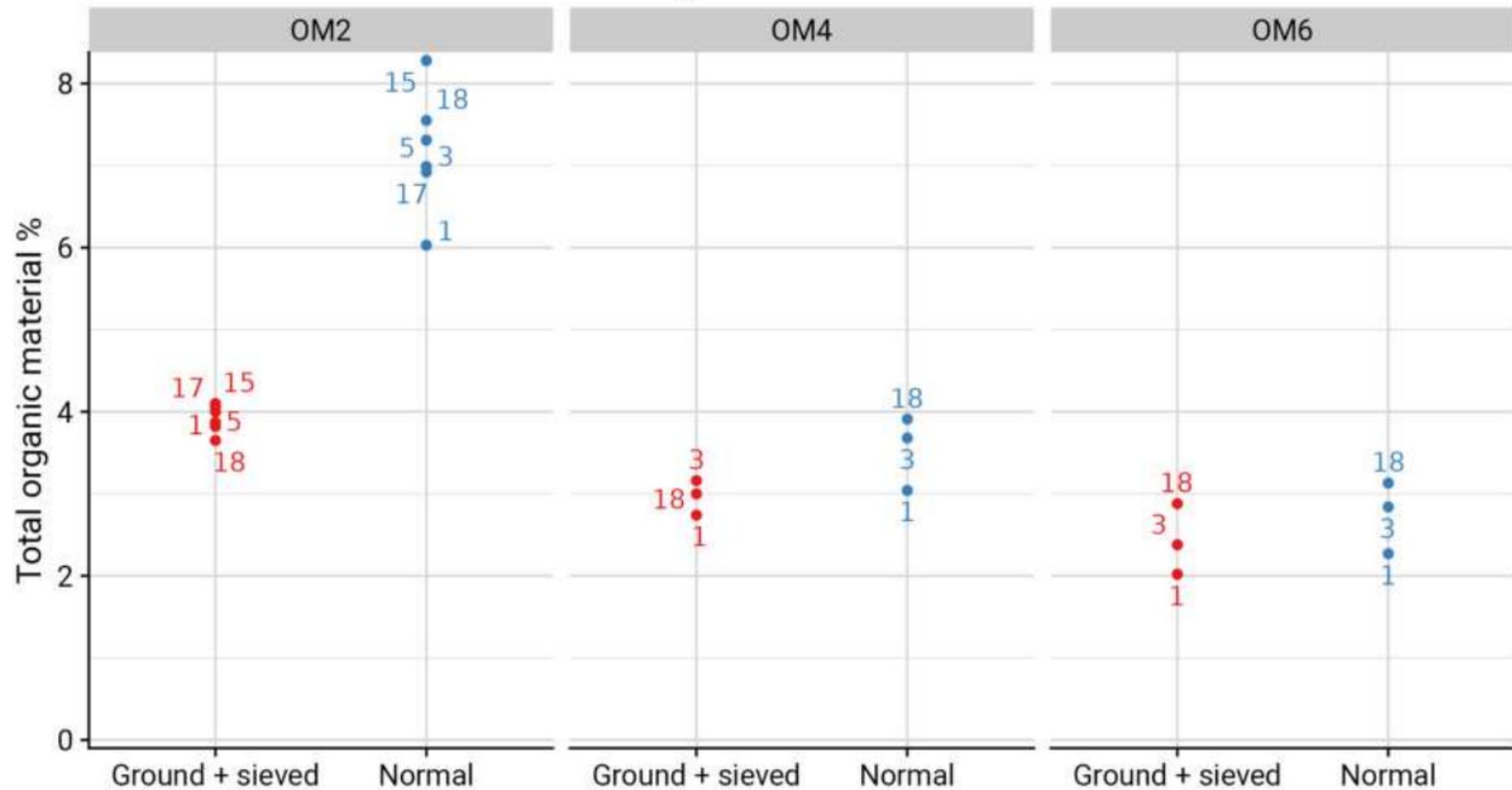
# At the laboratory







# OM246 test results on sieved samples



# Playing conditions

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RIZAP KBCオーガスタゴルフトーナメント 2017

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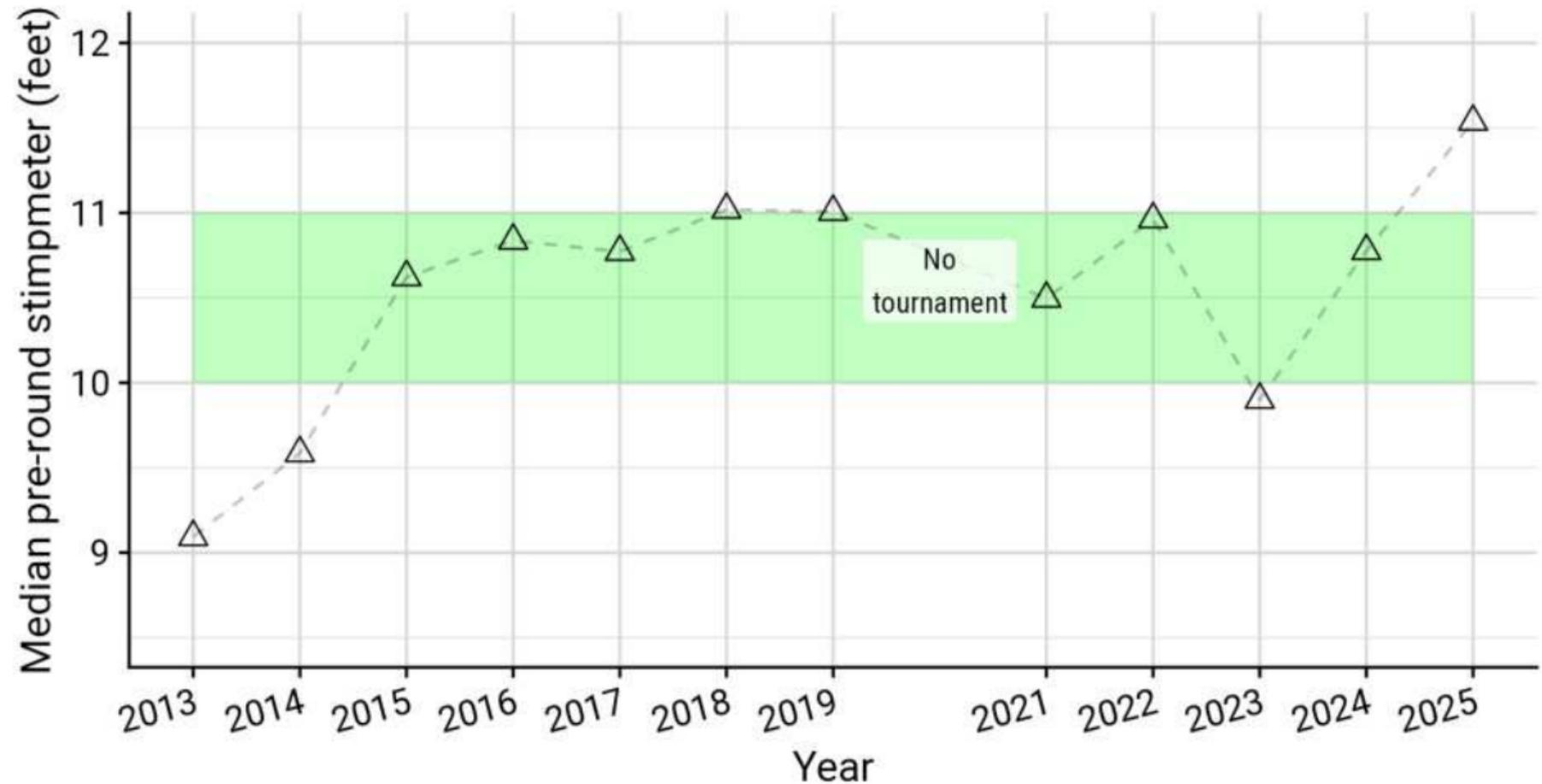


## What to measure?

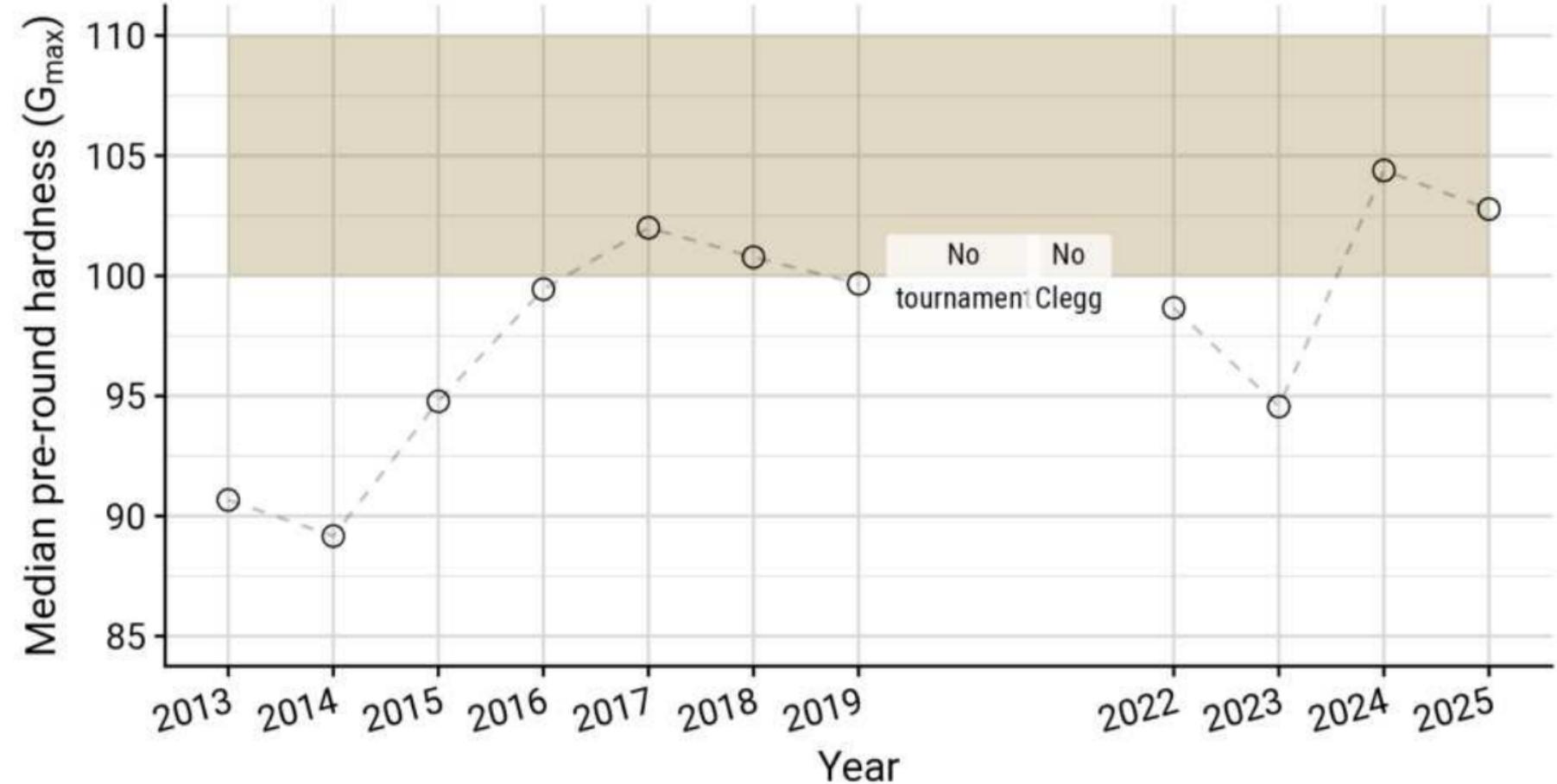
- Stimpmeter
- Bobble test (smoothness, trueness)
- Surface hardness (firmness)



# KBC Augusta tournament week green speed



# KBC Augusta tournament week surface hardness



# Comparing Three Methods to Measure Putting Green Trueness

Douglas T. Linde,\* Andrew D. Mitchell, and Brendan Hannan

## ABSTRACT

Since there was not a standard method to measure putting green trueness, a golf course and plot study were conducted to compare three methods to measure putting green trueness. In 2013, the Royal & Ancient (R&A) "Holing Out Test" (HOT), a visual bobble test, and a ball spread test were conducted on 150 greens from 50 New Zealand golf courses. In 2015, a plot study was conducted to compare the methods

D.T. Linde, Plant Science Dep., Delaware Valley Univ., 700 E. Butler Ave., Doylestown, PA 18901; A.D. Mitchell and B. Hannan, New Zealand Sports Turf Institute, P.O. Box 347, Palmerston North, NZ 4440. Received 12 May 2016. Accepted 6 June 2017. \*Corresponding author (douglas.linde@delval.edu). Assigned to Associate Editor Scott Ebdon.

**Abbreviations:** HOT, Holing Out Test; NZSTI, New Zealand Sports Turf Institute; PGA, Professional Golfers Association of America; R&A, Royal & Ancient; STRI, Sports Turf Research Institute; USGA, United States Golf Association.

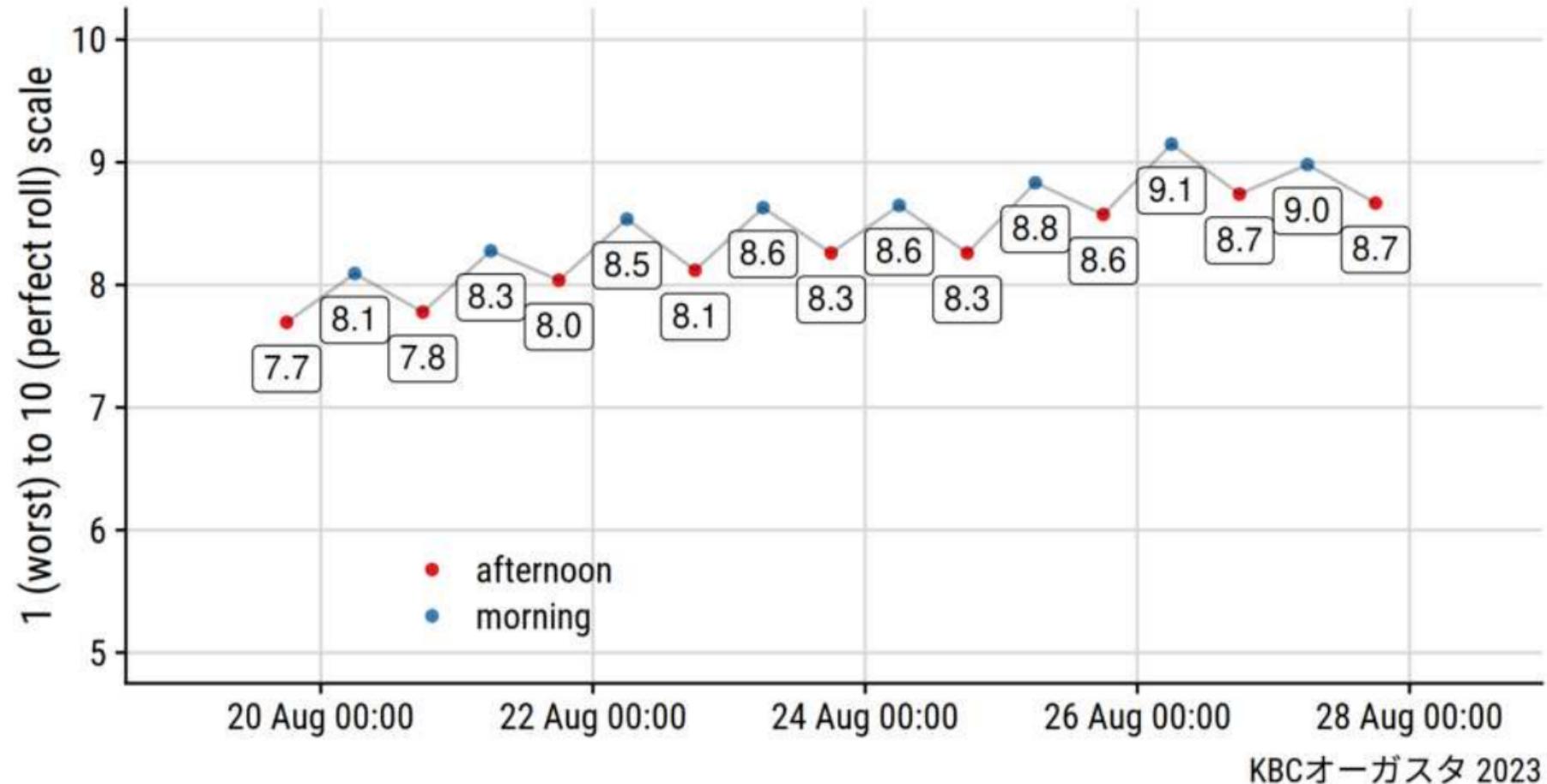


least putts on a core-aerated green without topdressing. Based on the survey, most golfers assessed trueness visually by how many times the ball bounces as it rolls. However, the similar ranking of the photos by most respondents indicated that golfers also assessed trueness based on the appearance of the surface.

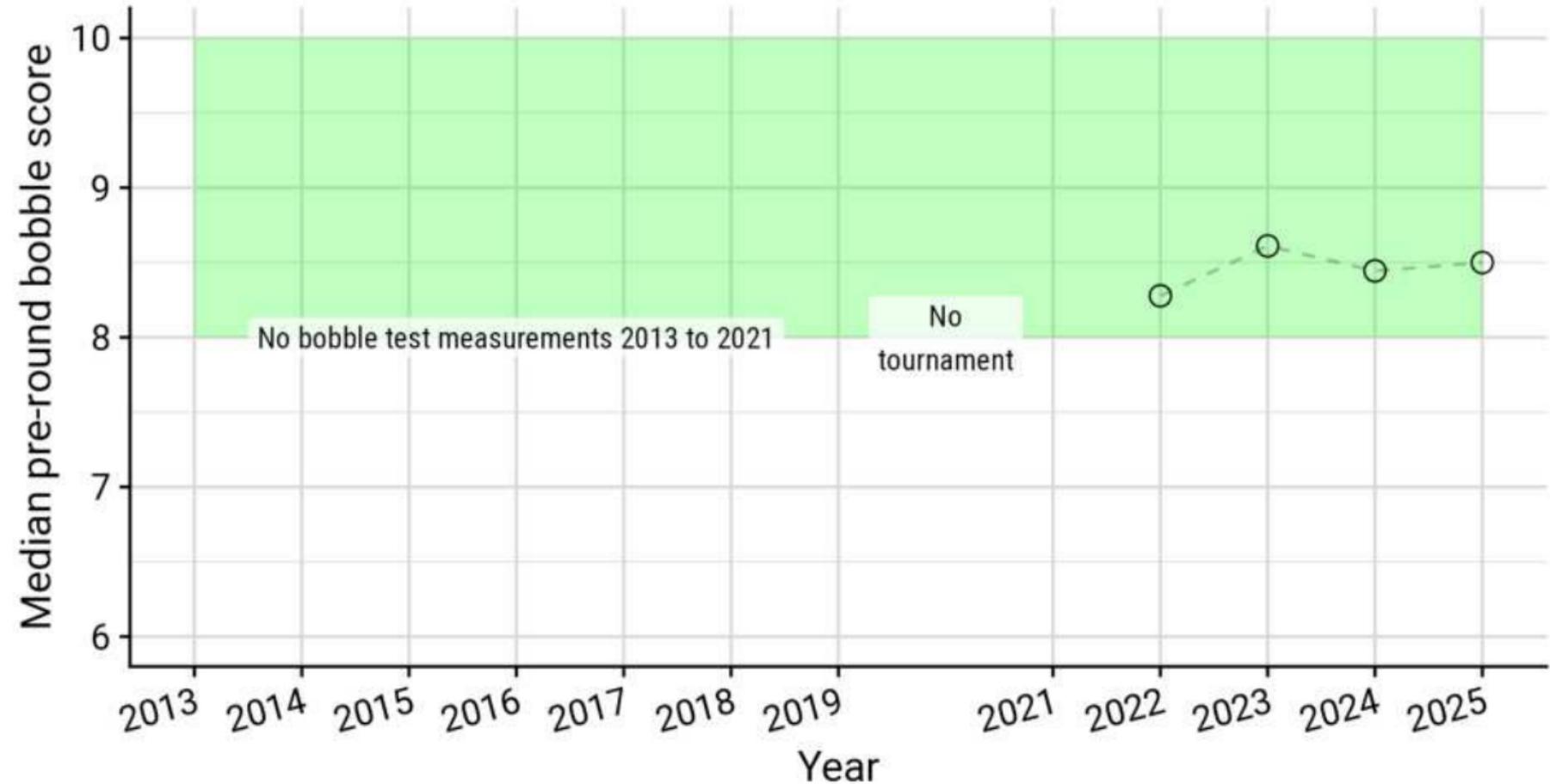


The golf course and plot studies had similar results. Both had weak correlations and a large difference in sensitivity between the HOT and the other methods. Thus, the HOT was not measuring the same characteristics as the other methods. The bobble test was the easiest method to administer, took the least time to conduct, and measured a wide range of trueness. The HOT was the least effective method to measure trueness and was difficult to administer. On many of the greens tested, rolled balls

# Average bobble test



# KBC Augusta tournament week surface smoothness & trueness



# Nutrient supply

---



## リン (P)

mg/kg



## カリウム (K)

mg/kg



1. Slow-growing grass
2. 100% of nutrients supplied as fertilizer
3. 100% of nutrients supplied by soil + fertilizer
4. All that really needs adjusted is nitrogen (N)



DAWSON  
IPA

DAWSON  
IPA

SASSY  
IPA

Volt-Damm  
IPA

St. Bernard  
Tripel

BELIRUKA  
Octopium

CASTLE  
IPA

STRAFFE  
HENDRIK

Tripel  
Amelet

STRAFFE  
HENDRIK

VEDET  
IPA

DAWSON  
IPA

WATERLOO  
Triple Blond

DAWSON  
IPA

# Harmonization with the Turf GvX

---

The **Turf GvX** is the actual growth of the grass compared to the expected growth of the grass.

## Use the GvX for ...

- adjusting N fertilizer
- adjusting plant growth regulators

## Results may include ...

- Improved playing conditions
- Fewer inputs (N, sand, mowing)
- Species composition improvements

The **Turf GvX** is the actual growth of the grass compared to the expected growth of the grass.





# What should my ClipVol be?

turf GvX ClipVol growth potential

Micah Woods

2023-03-30 · 2 min read

This is a common question. I heard another one recently, too. "How big of a bucket should I get to measure clipping volume?"

I like to answer these questions by looking at the site-specific conditions. One can use the turf GvX to get an idea for what a normal amount of clipping volume might be for your site.

The amount of clippings are going to be influenced by three main factors. One is weather. For example, I'd expect no clipping volume in Alaska in January, but some amount of clipping volume in July. A second factor is the grass species or variety being grown. There must be some differences here, but they may not be as big as you think. From looking at data from different grass species around the world, managing turf to produce a high quality putting surface tends to converge on similar clipping volumes. A third factor is how you like to—or how you need to—manage the grass. A course with 12,000 rounds can probably be managed with a really low clipping volume. A course with 60,000 rounds, maybe with that amount of traffic a higher growth rate (clipping volume) would be more appropriate.

The GvX accounts for *all* of these factors. Because the PACE Turf growth potential is already included in the GvX calculation, the weather effects are already included by

*Turfgrass Speedo*

# Some Turf GvX history

II

12/20/2017 12:20:00 PM

12/20/2017 12:20:00 PM

12/20/2017 12:20:00 PM



12/20/2017 12:20:00 PM

# Turfgrass Speedo

December 17, 2018

**H**ow fast should we grow our grass? It's a question I have been asking on this blog for almost 7 years now and every year I think I get a bit better. I explained this evolution last year in a blog post called "[The Evolution of Precision Fertilizer Application](#)."



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***Turfgrass speedo is still my most important tool for managing turf growth after 4 years.***

November 19, 2022



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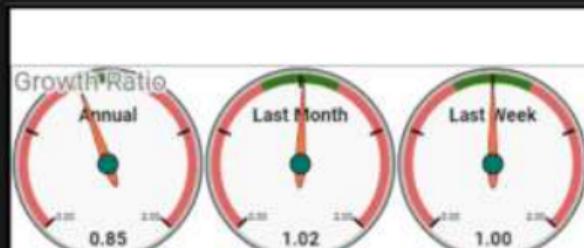
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## Mid Winter Growth Ratio Update

January 17, 2023

Here's a quick update on how I use the growth ratio tool. You can see all of this data live [here](#).

It's my first day of the work week and always like to look at my maintenance dashboard after getting my set up for the day. Today I noticed that the growth ratio is almost exactly at 1. Essentially we have cut exactly the amount of grass that the model suggests we cut.



Contact me

I would love to talk with anyone interested about these topics or anything else. I can be reached via email or phone. Thanks!

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# The turf GvX: growth versus expected

TurfGvX [Clip this](#)

Micah Woods

2024-08-11 · 3 min read



We've been working on this one for a long time. We've had the turfgrass speedometer (or speedo), which can also be called the growth ratio. Both of those names have some problems. Not distinct enough, in the case of the growth ratio, and too distinct, perhaps, in the case of the speedo.

I'm pleased to introduce a new name for the same metric: Turf GvX. This rolls off the tongue, makes a nice #TurfGvX hashtag, and it is a short form of turfgrass growth versus

# Actual growth

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The standard units for clipping volume  
(ClipVol) are mL/m<sup>2</sup> or L/1000 m<sup>2</sup>.

# Expected growth

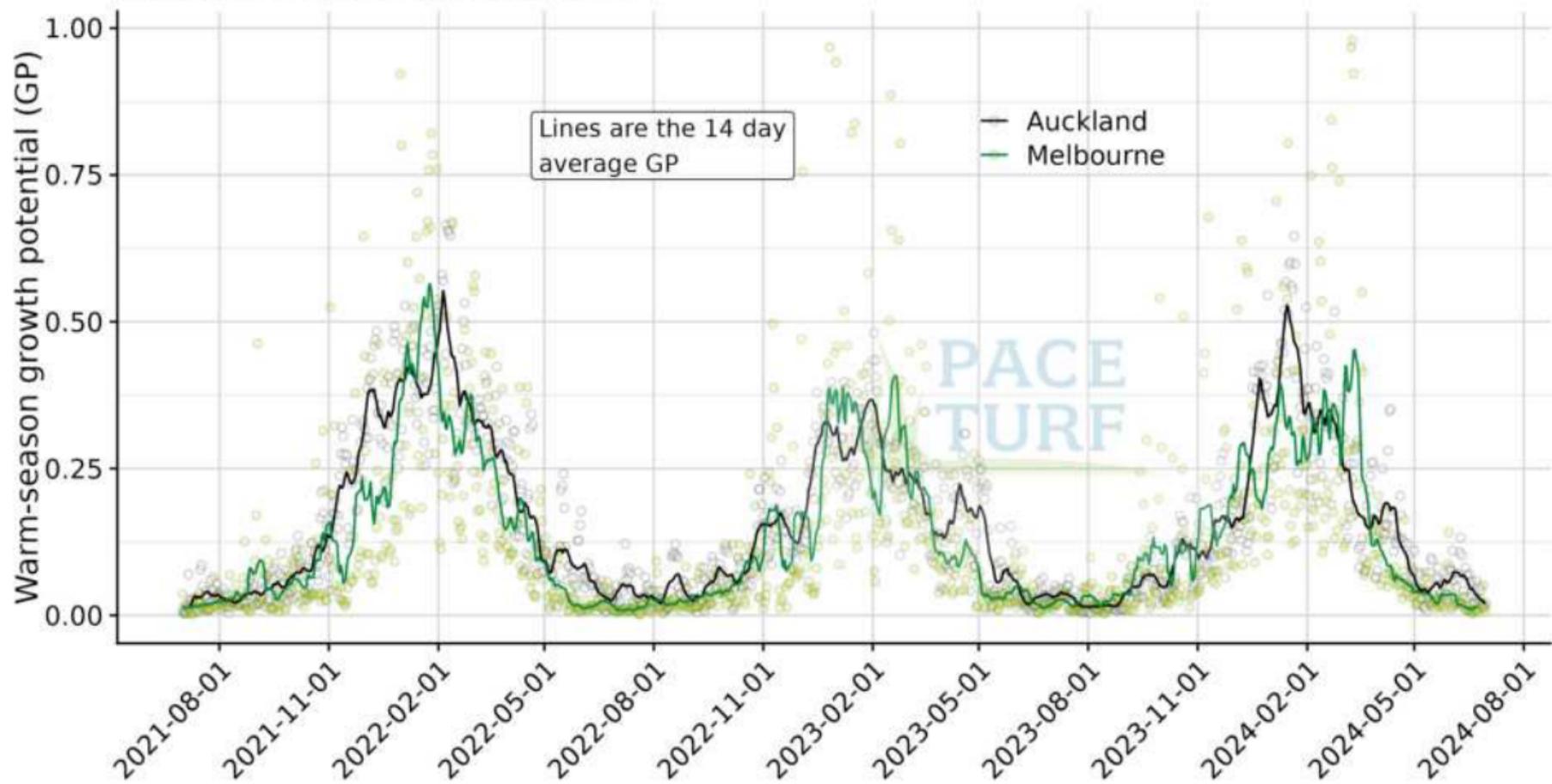
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# Daily warm-season grass growth potential at Auckland and Melbourne

from 1 July 2021 through 30 June 2024



# Calculating the GvX

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$$GvX = \frac{ClipVol_{14}}{20 \times GP_{14}} \times 100$$

where  $ClipVol_{14}$  is the 14 day average of clipping volume and  $GP_{14}$  is the 14 day growth potential average.

[www.asianturfgrass.com](http://www.asianturfgrass.com)

[www.paceturf.org](http://www.paceturf.org)

