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

Micah Woods, Ph.D.

February 4, 2026

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www.asianturfgrass.com

PACE Turf
www.paceturf.org

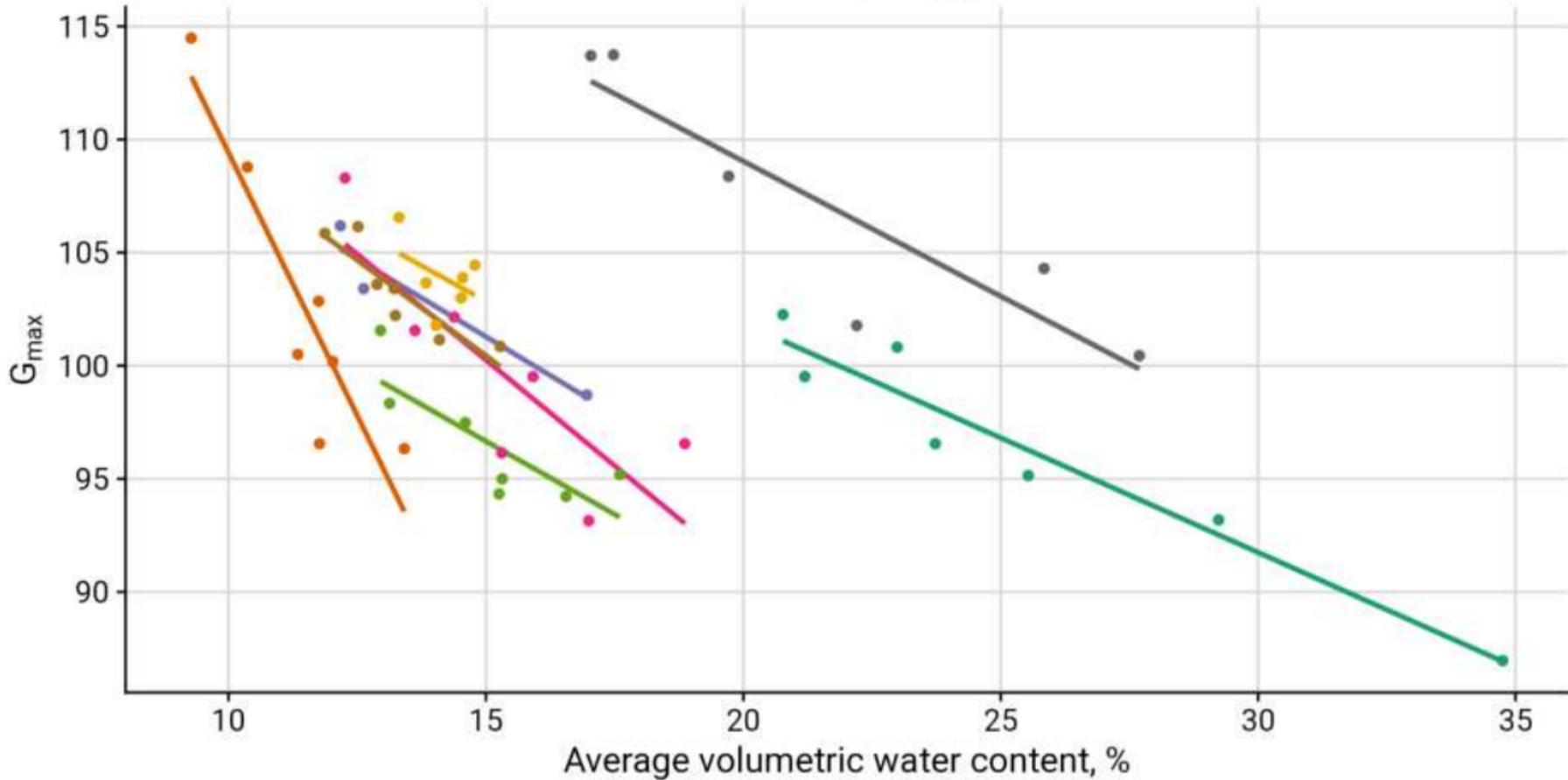








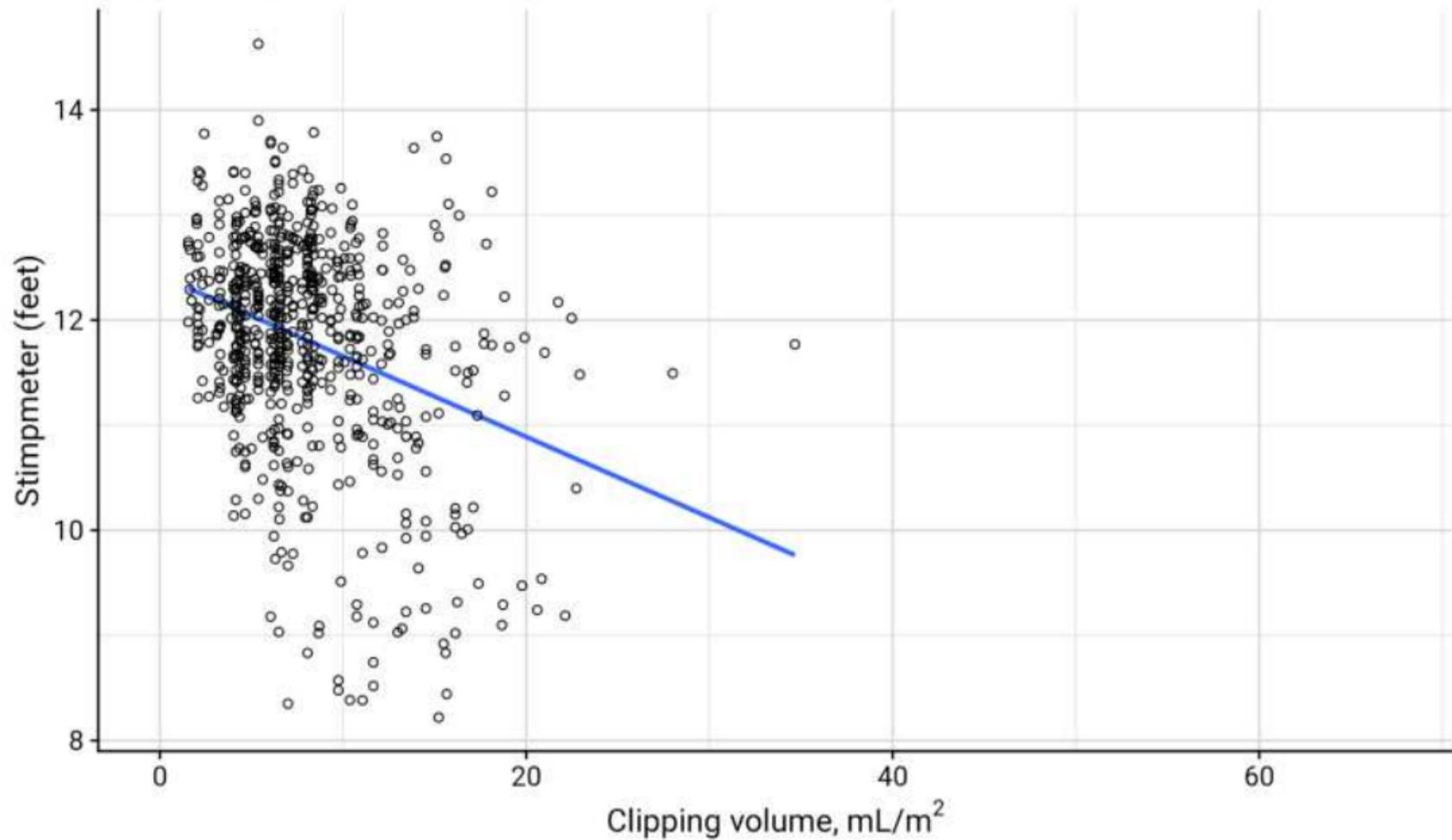
Soil water content vs. surface hardness (Clegg)



Morning measurements from practice rounds and tournament days at eight tournaments



Paired daily measurements



Our afternoon outline

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

Growth rate

Machine and cutting unit setup and clipvol variation





Video time stamp: 1 second



Video time stamp: 4 seconds



Video time stamp: 10 seconds







Estimate dry mass as 6.3% of the fresh clipvol



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**.

Normal nutrient content of bentgrass leaves

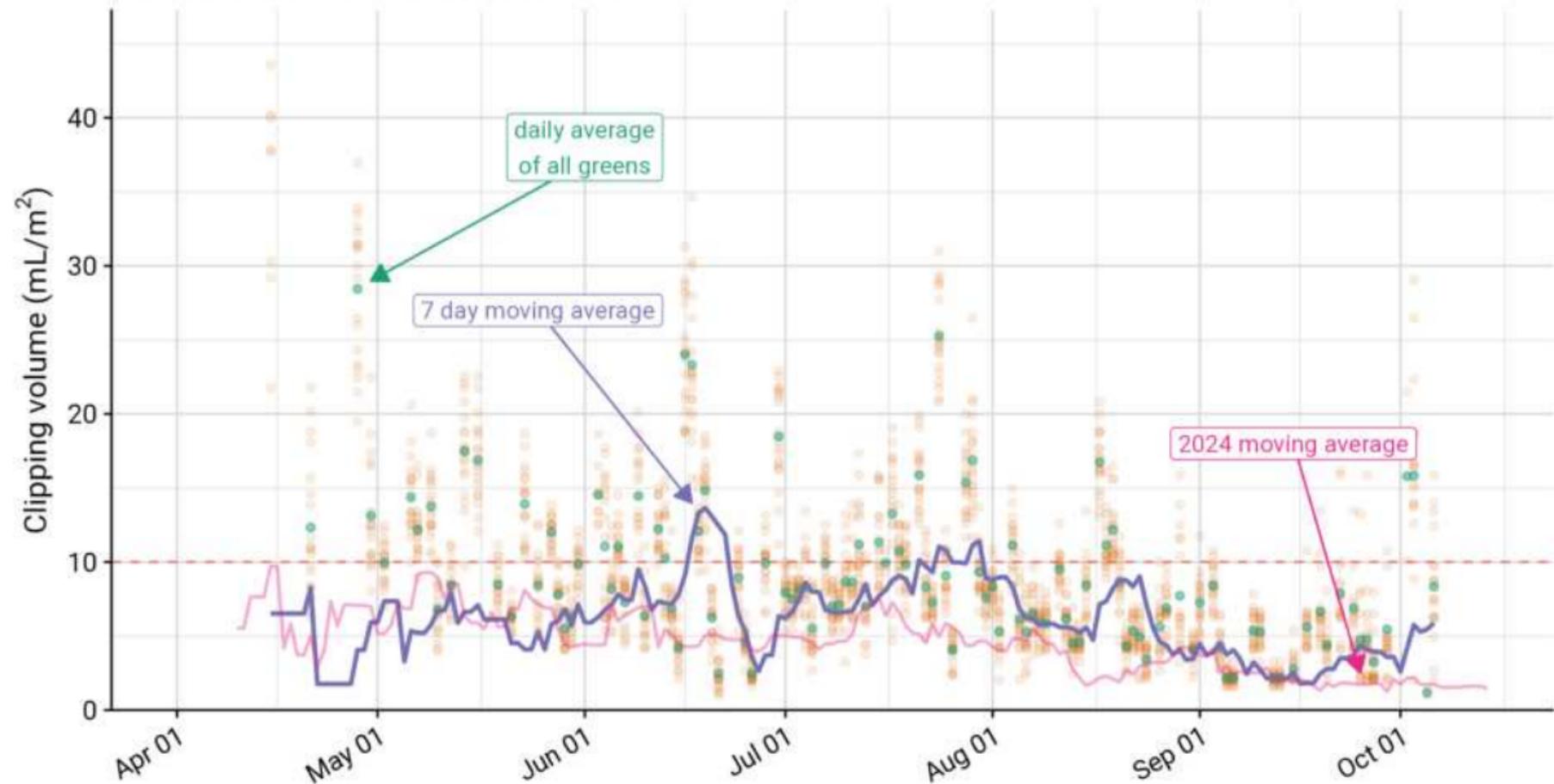
Element	Concentration (%)		
	10 th percentile	Median	90 th percentile
N	3.4	4.6	5.9
P	0.36	0.52	0.68
K	1.4	1.9	2.5
Ca	0.41	0.58	0.75
Mg	0.17	0.23	0.28
S	0.41	0.56	0.72

Normal nutrient content of fine fescue leaves

Element	Concentration (%)		
	10 th percentile	Median	90 th percentile
N	1.4	3.0	4.6
P	0.19	0.40	0.61
K	1.2	1.9	2.6
Ca	0.22	0.45	0.67
Mg	0.09	0.16	0.23
S	0.17	0.38	0.59



Morning clipping volume in 2025

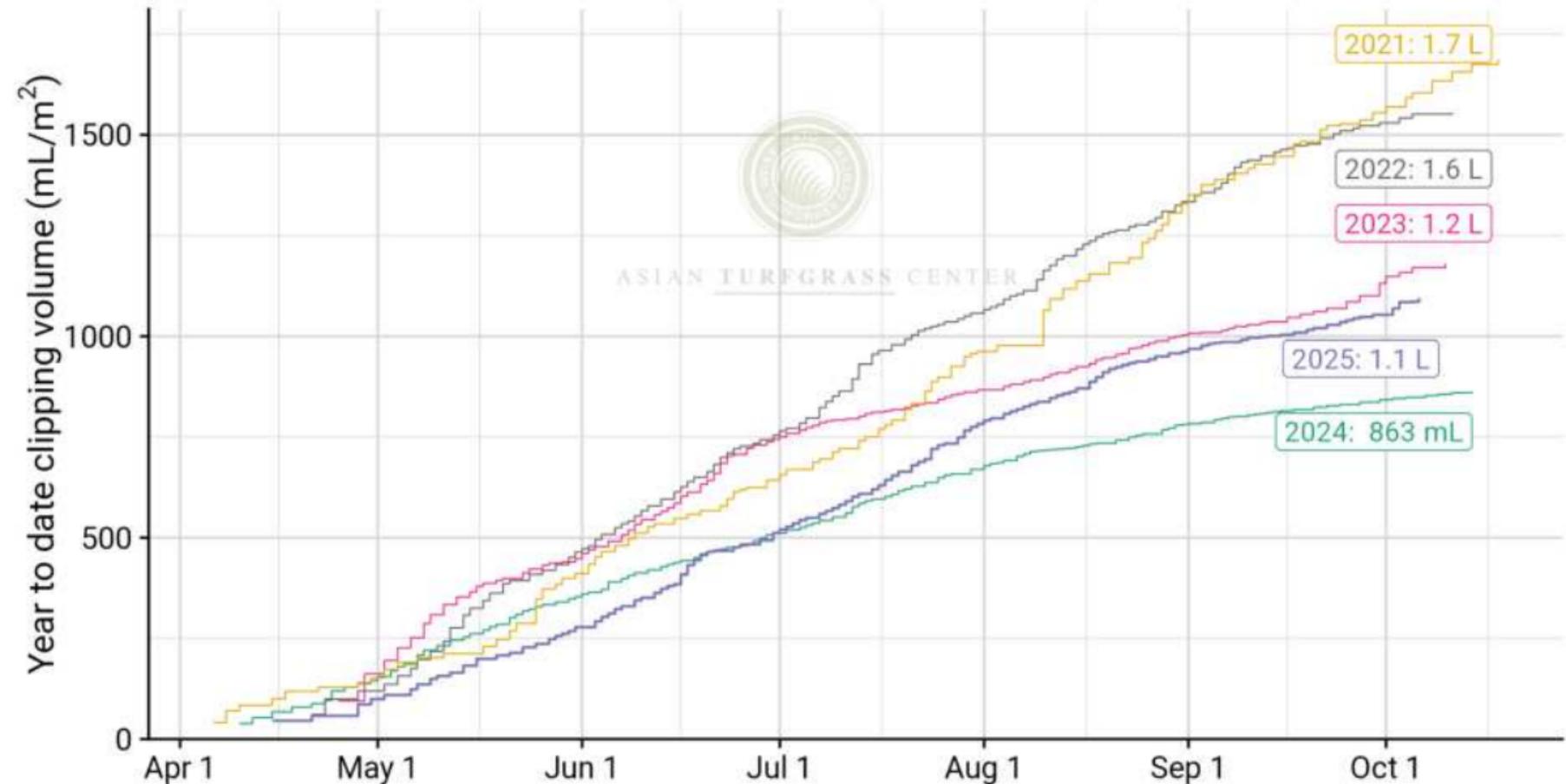


Cumulative clipping volume

Hazeltine National Golf Club



ASIAN TURFGRASS CENTER





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

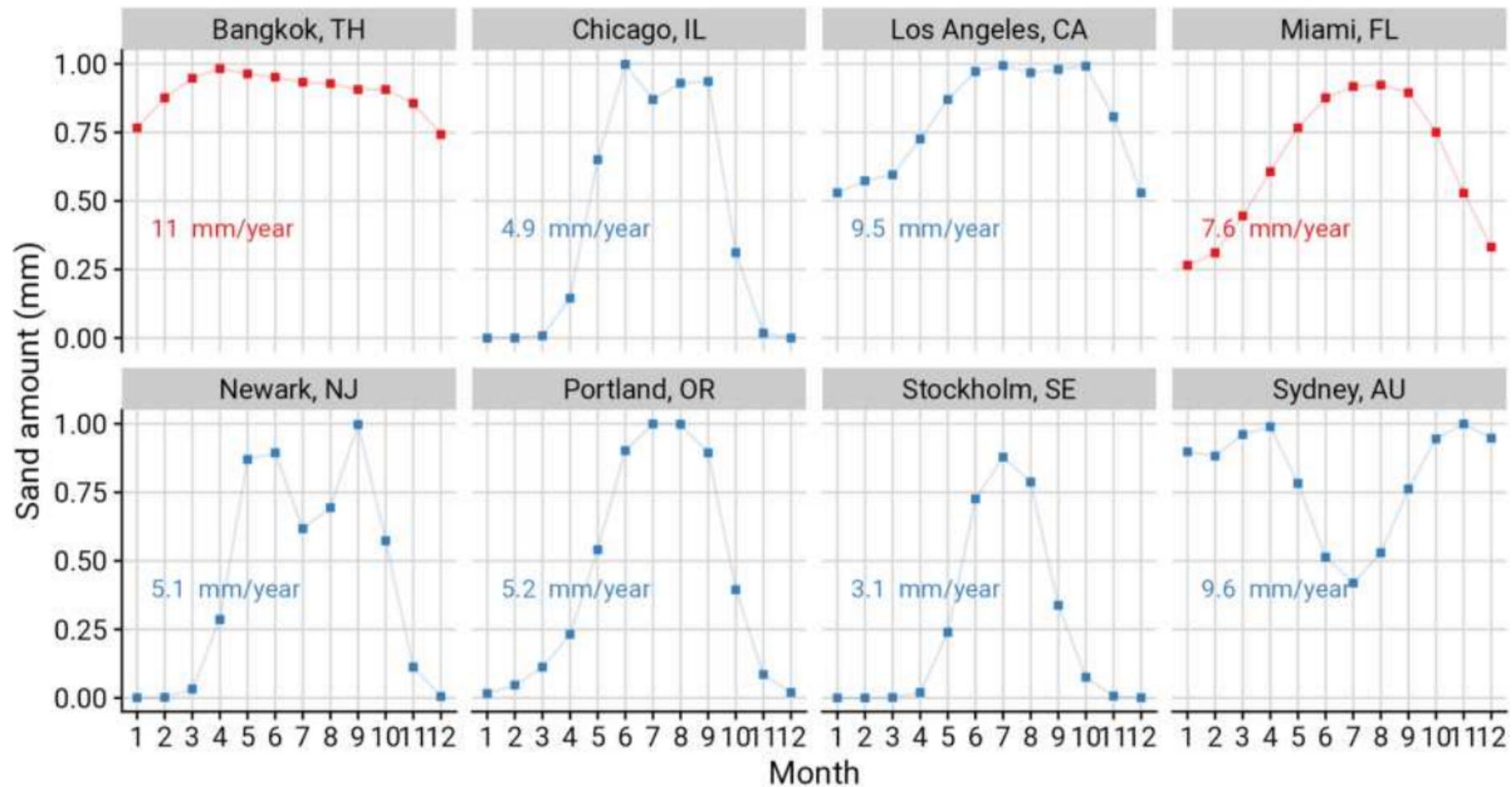
1. Reactive
2. Preventative
3. Condition-based
4. Predictive/prescriptive

Soil Organic Material

Know the sand application rate



Temperature-based growth potential prediction of sand topdressing



$$1 \text{ mm} \approx 320 \text{ lbs}/1,000 \text{ ft}^2$$

$$1 \text{ mm} \approx 3.3 \text{ ft}^3/1,000 \text{ ft}^2$$

$$1 \text{ mm} \approx 16 \text{ tons/ha}$$

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



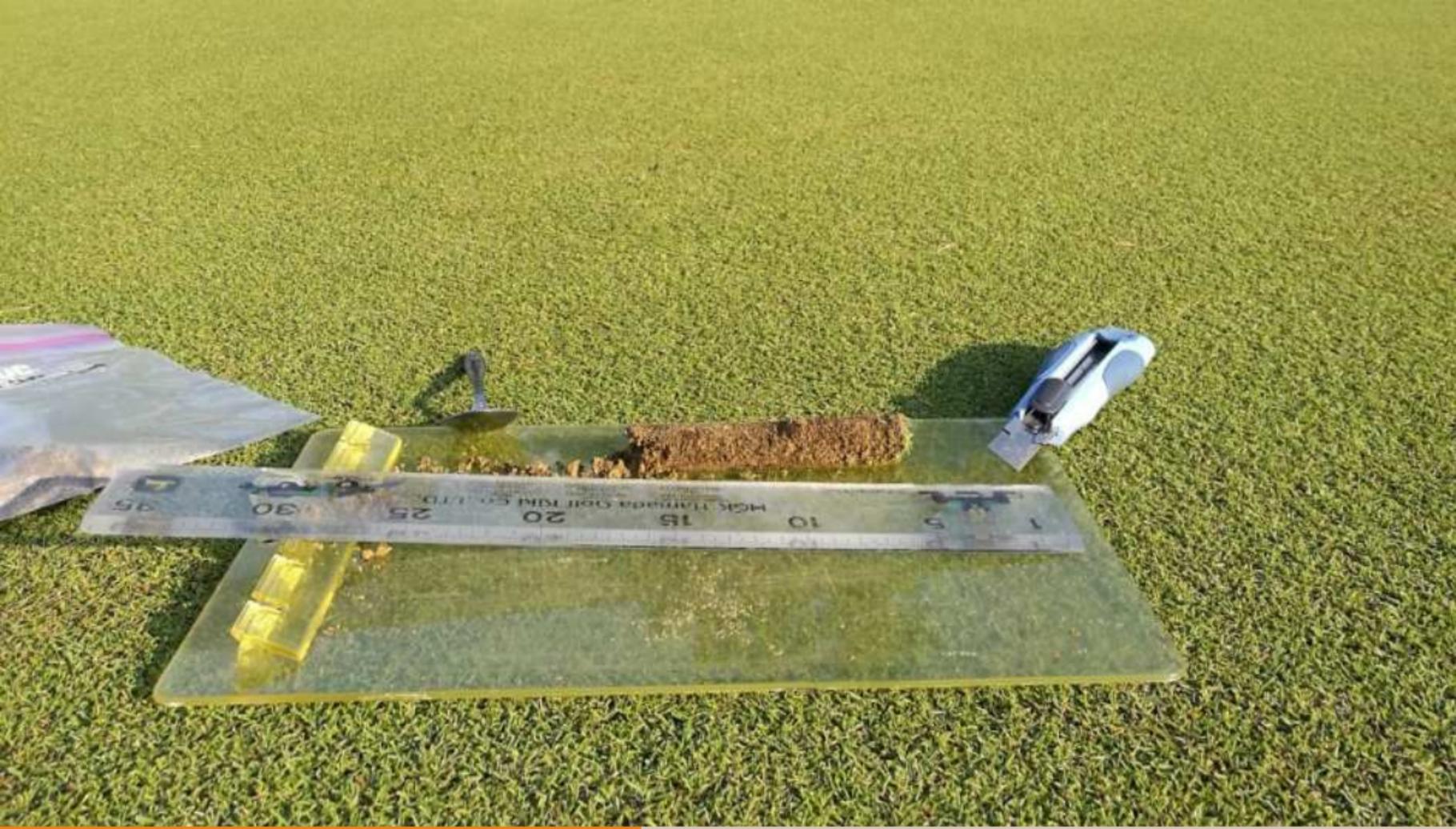
The definition of soil organic matter

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.



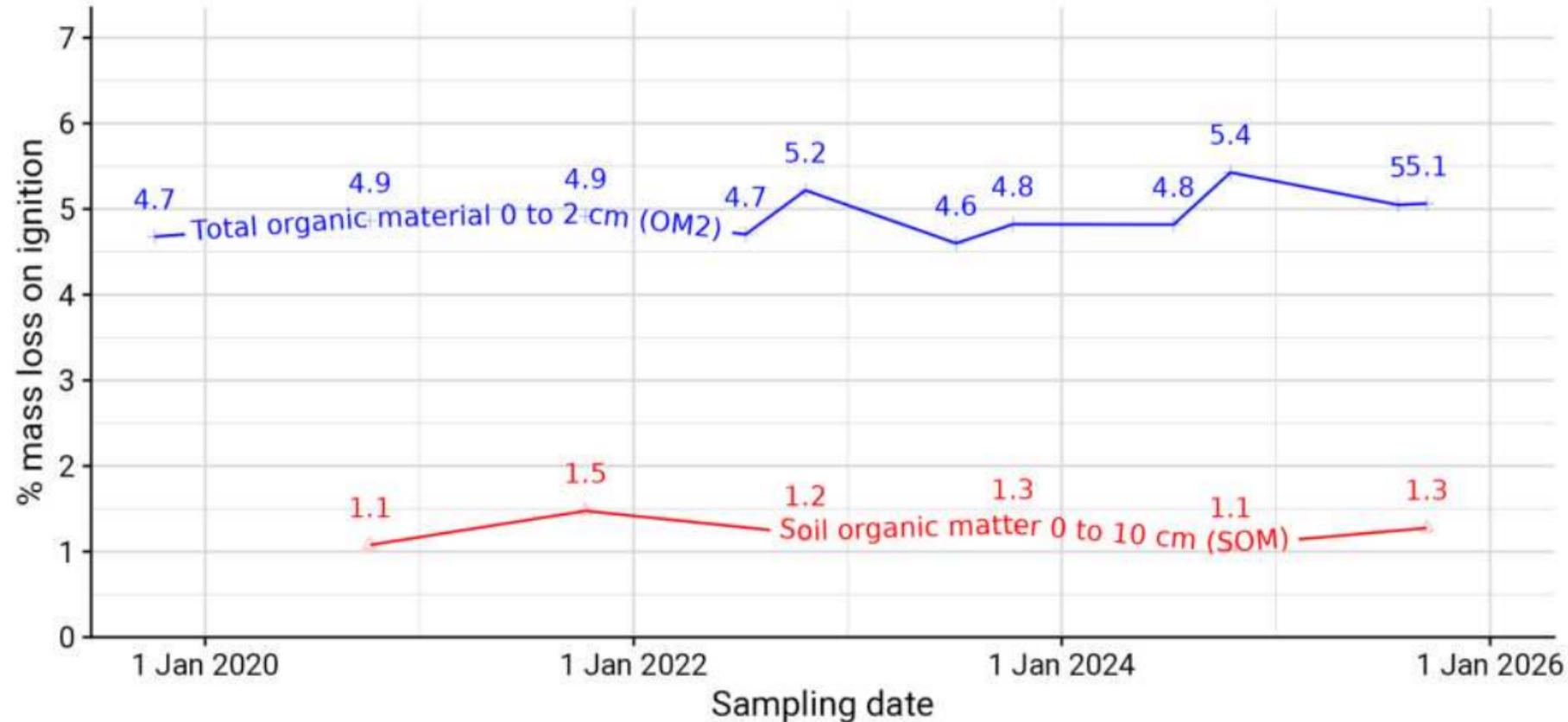






Creeping bentgrass putting greens

samples from Hazeltine National Golf Club



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



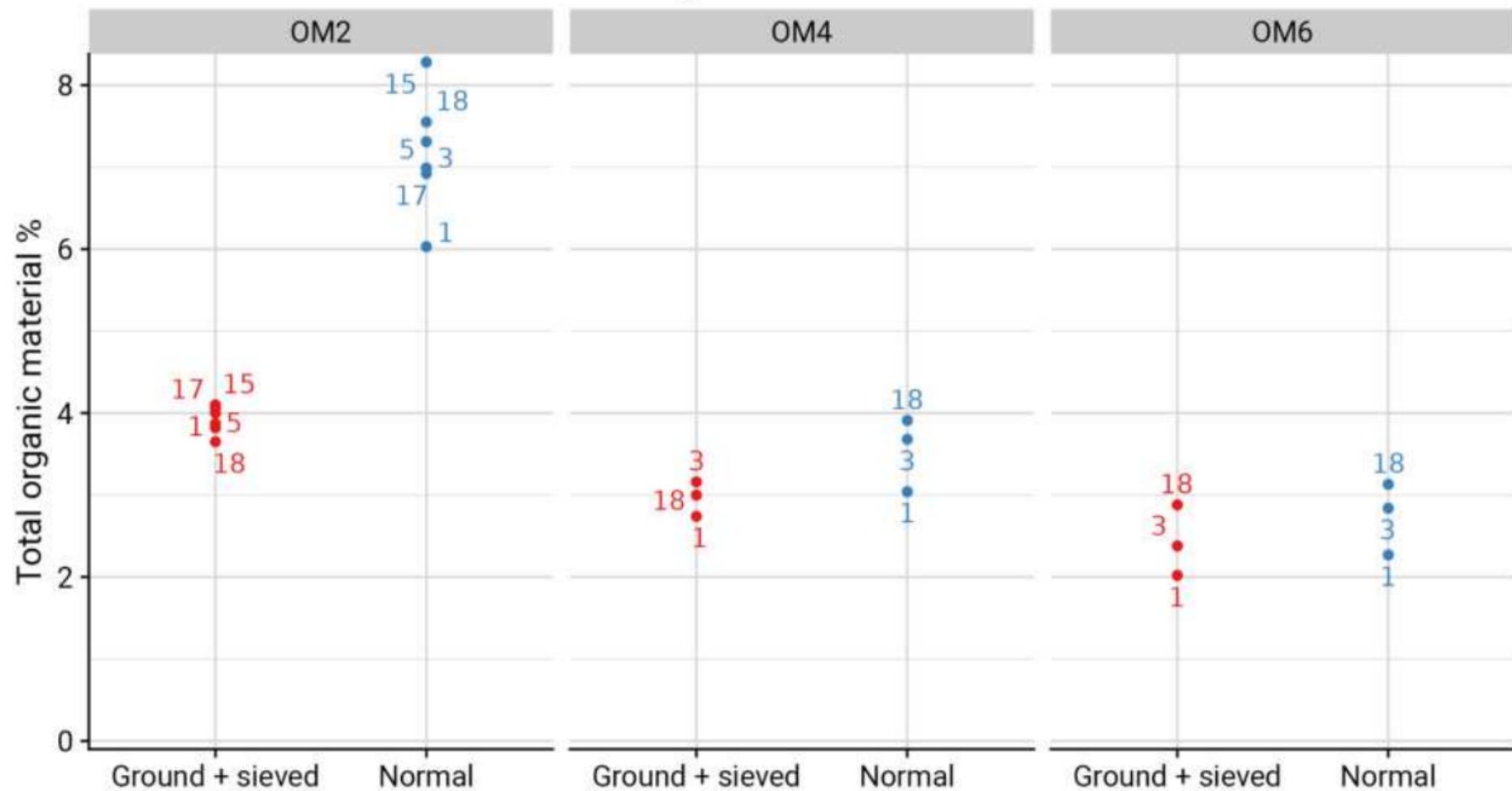
At the laboratory







OM246 test results on sieved samples



Playing conditions



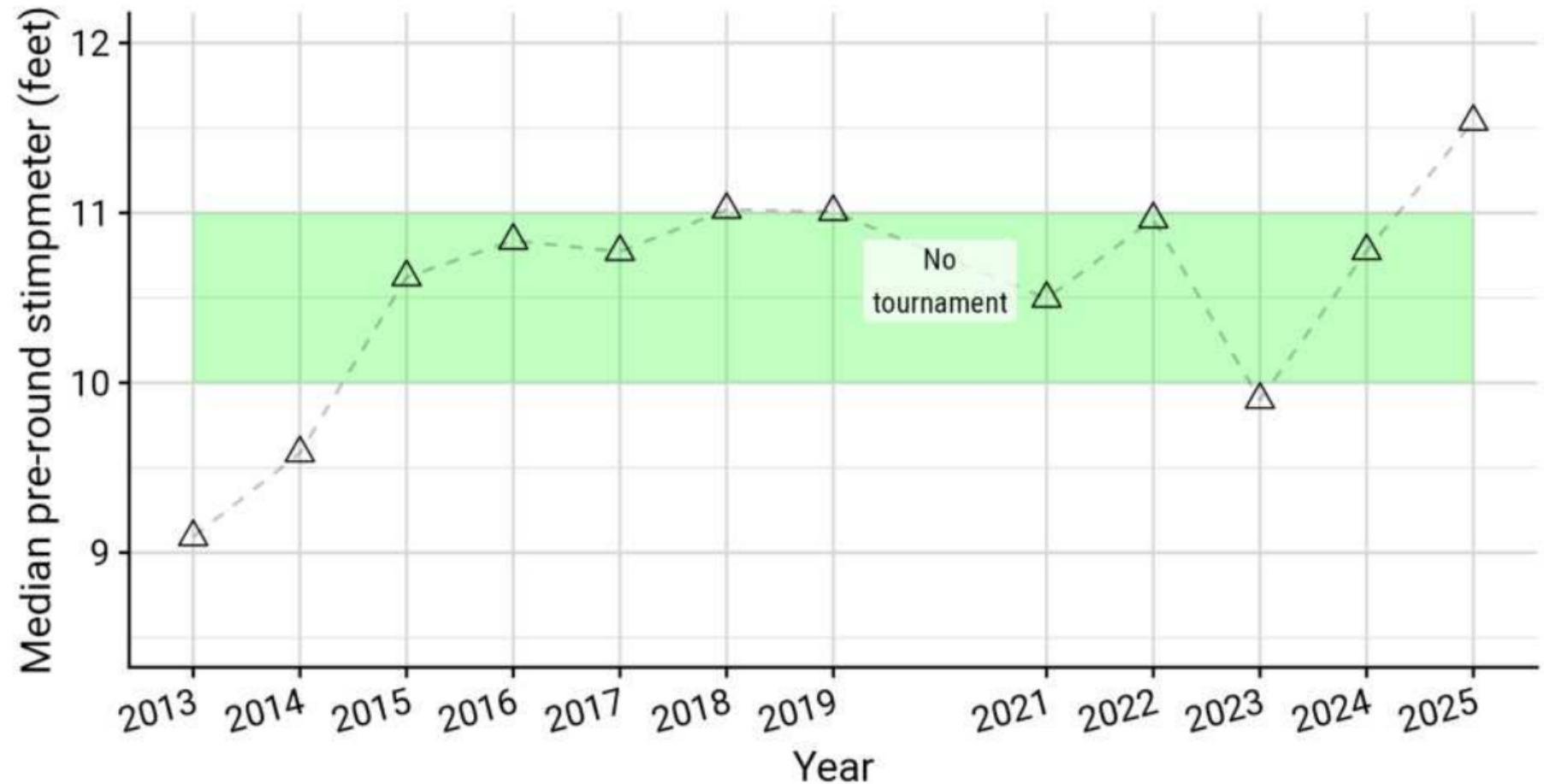


What to measure?

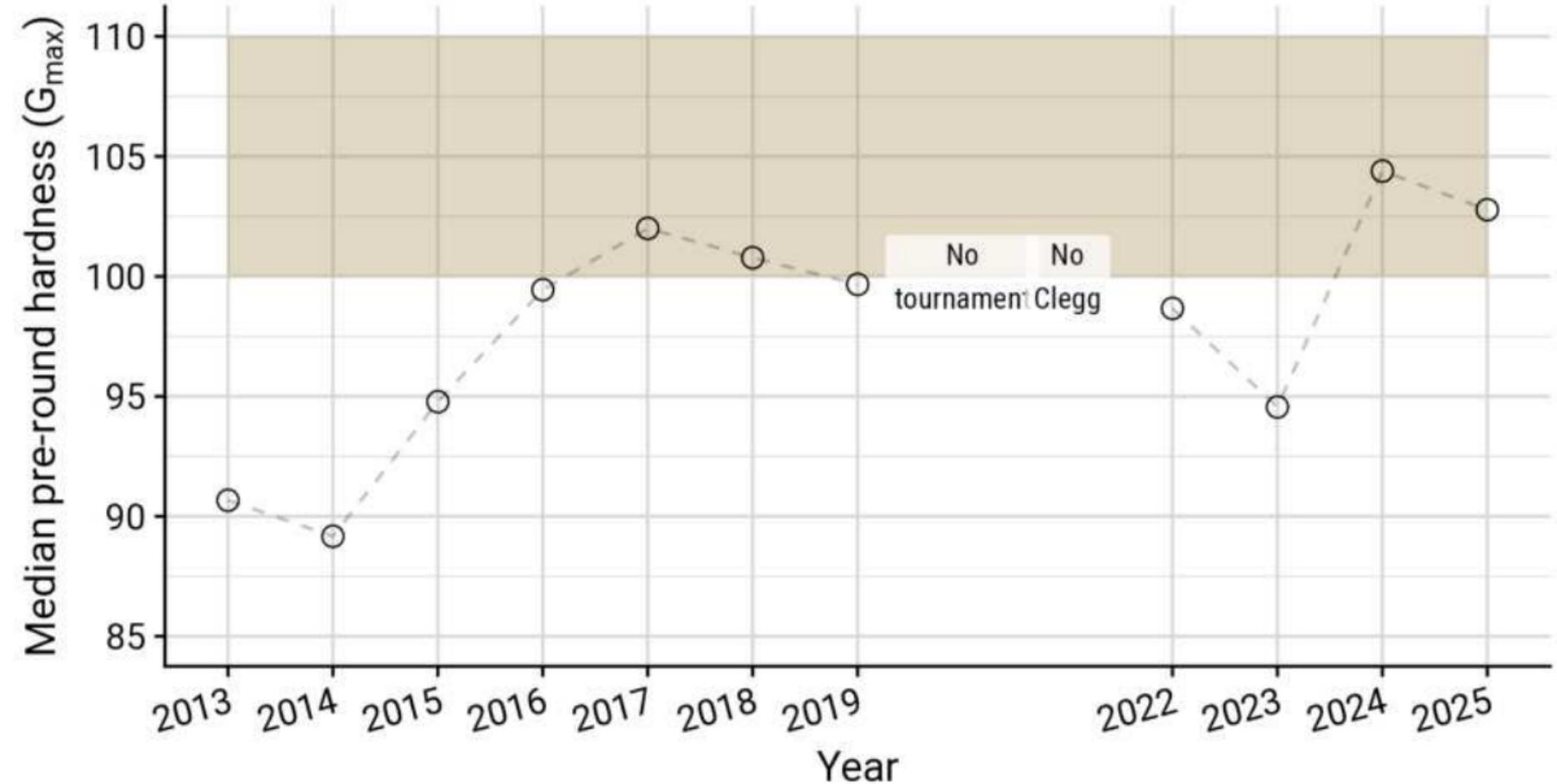
- Stimpmeter
- Bobble test (smoothness, trueness)
- Surface hardness (firmness)



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.

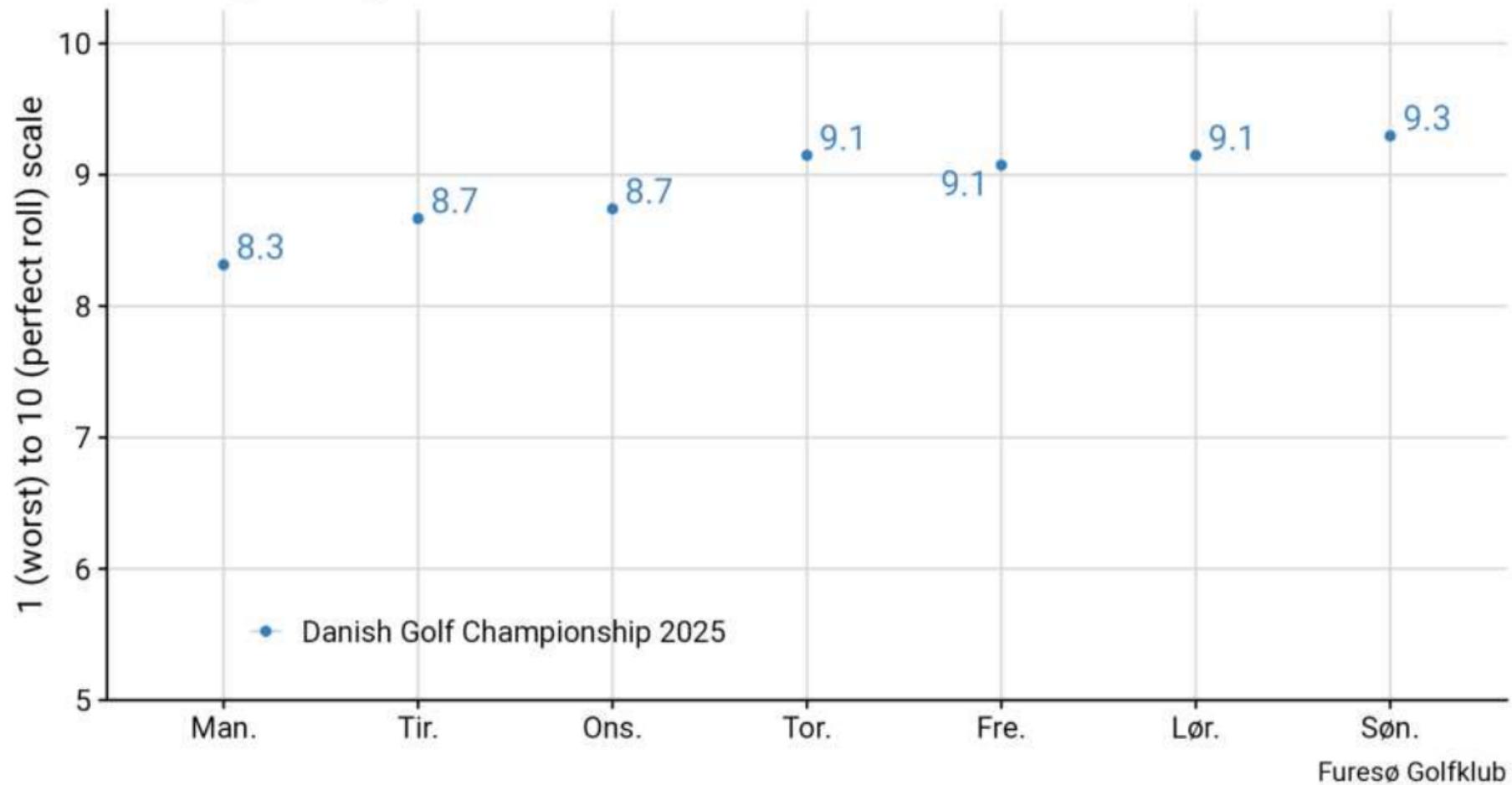


least putts on a core-aerated green without topdressing. Based on the survey, most golfers assessed trueness visually by how many times the ball bounces as it rolls. However, the similar ranking of the photos by most respondents indicated that golfers also assessed trueness based on the appearance of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

Morning average bobble test



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)



IPA

IPA

SASSY

Volt-Damm

St. Bernard Tripel

BELIRUKA
Octopium

CASTLE

STRAFFE
HENDRIK

Tripel
Armeliet

STRAFFE
HENDRIK

VEDET

IPA

STEREO
Triple Blond

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





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

Product (Turfgrass Speedo) (Turfgrass Speedo) (Turfgrass Speedo)

Product (Turfgrass Speedo)



Product (Turfgrass Speedo)

Product (Turfgrass Speedo) (Turfgrass Speedo) (Turfgrass Speedo)

Product (Turfgrass Speedo)

Turfgrass Speedo

December 17, 2018

How 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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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





The standard units for clipping volume
(ClipVol) are mL/m² or L/1000 m².

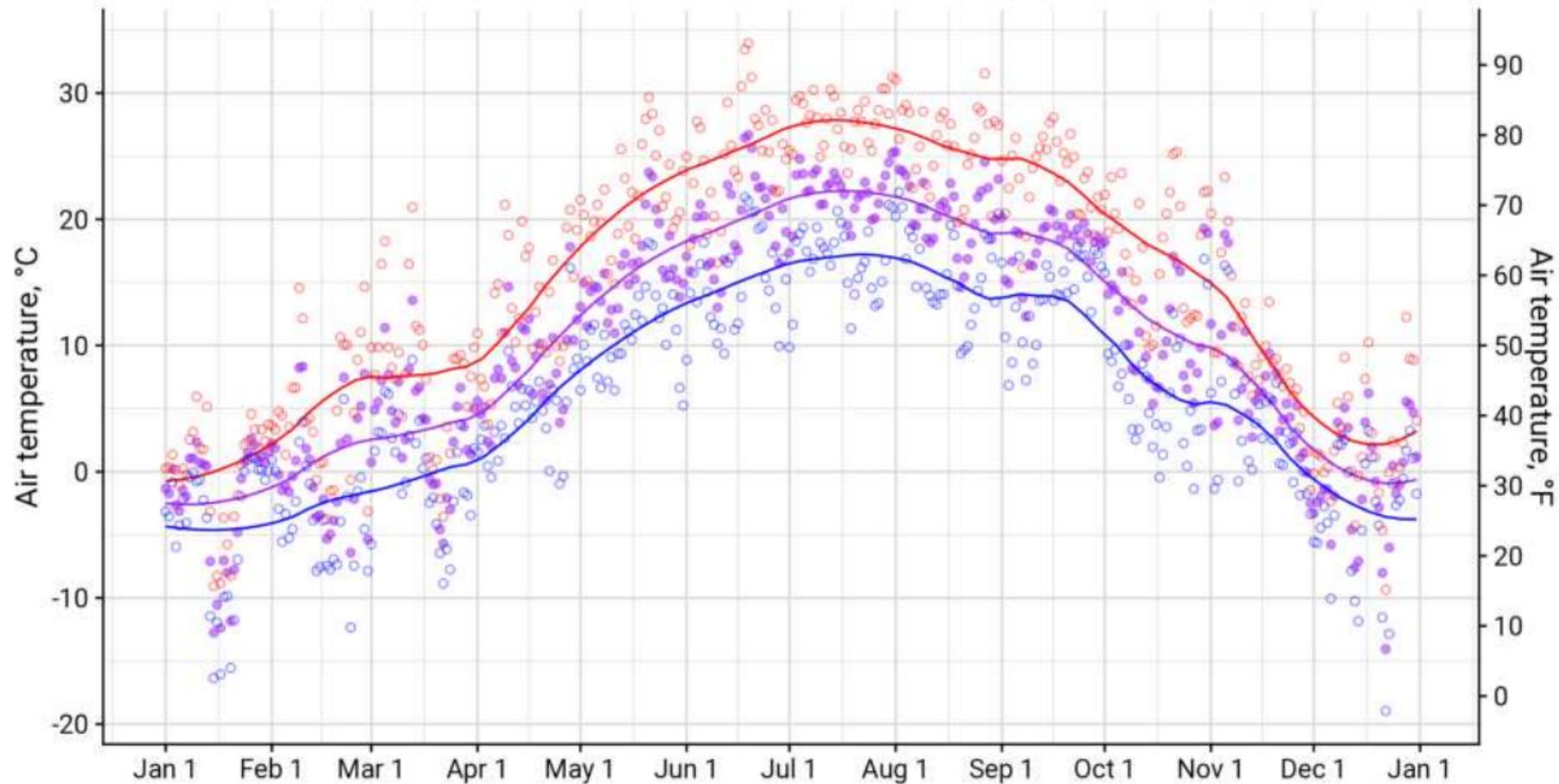
Expected growth



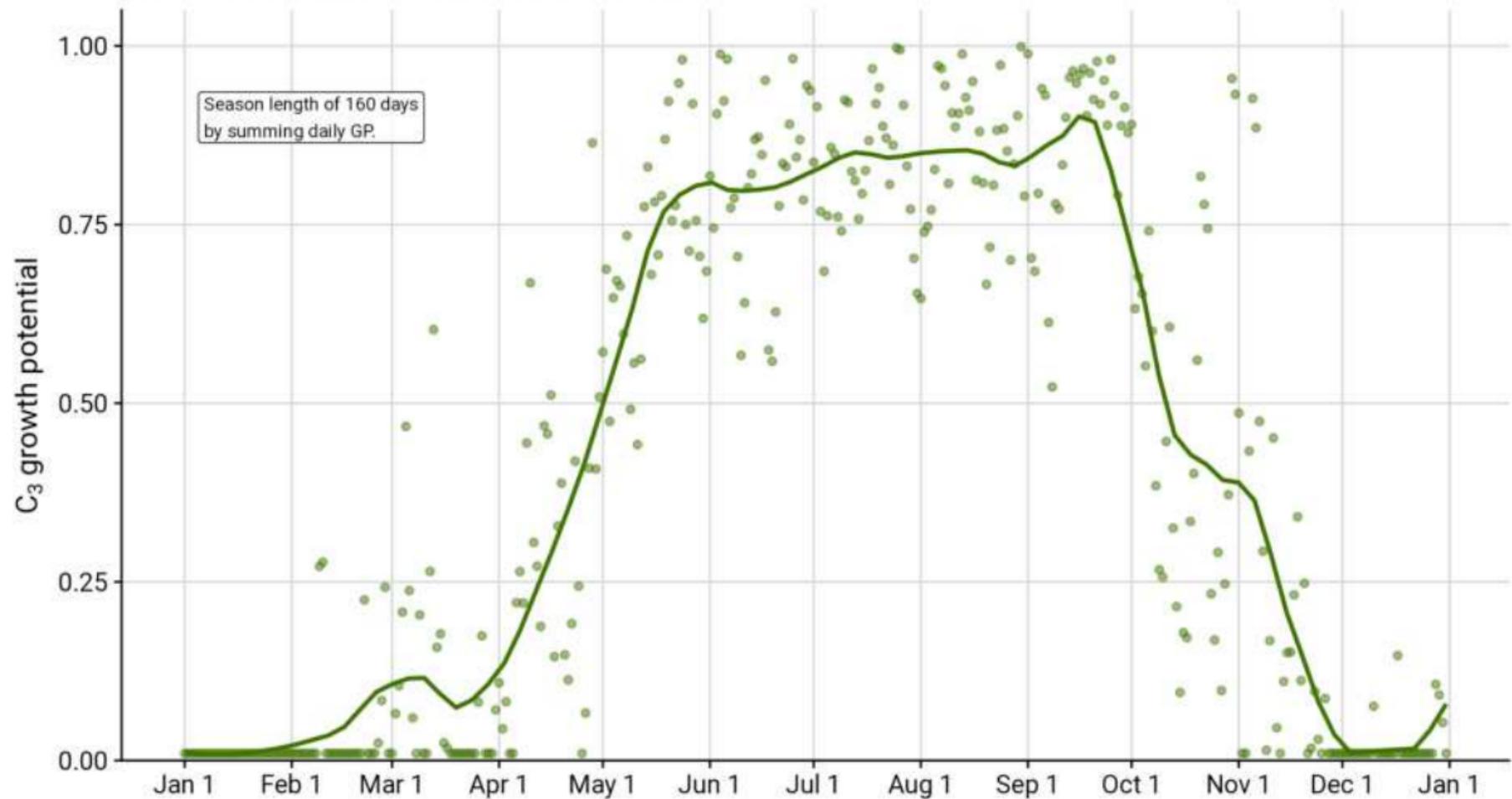


Daily temperature summary in 2024

Hamilton



Growth potential at Hamilton in 2024



Calculating the GvX

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

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

Using the GvX

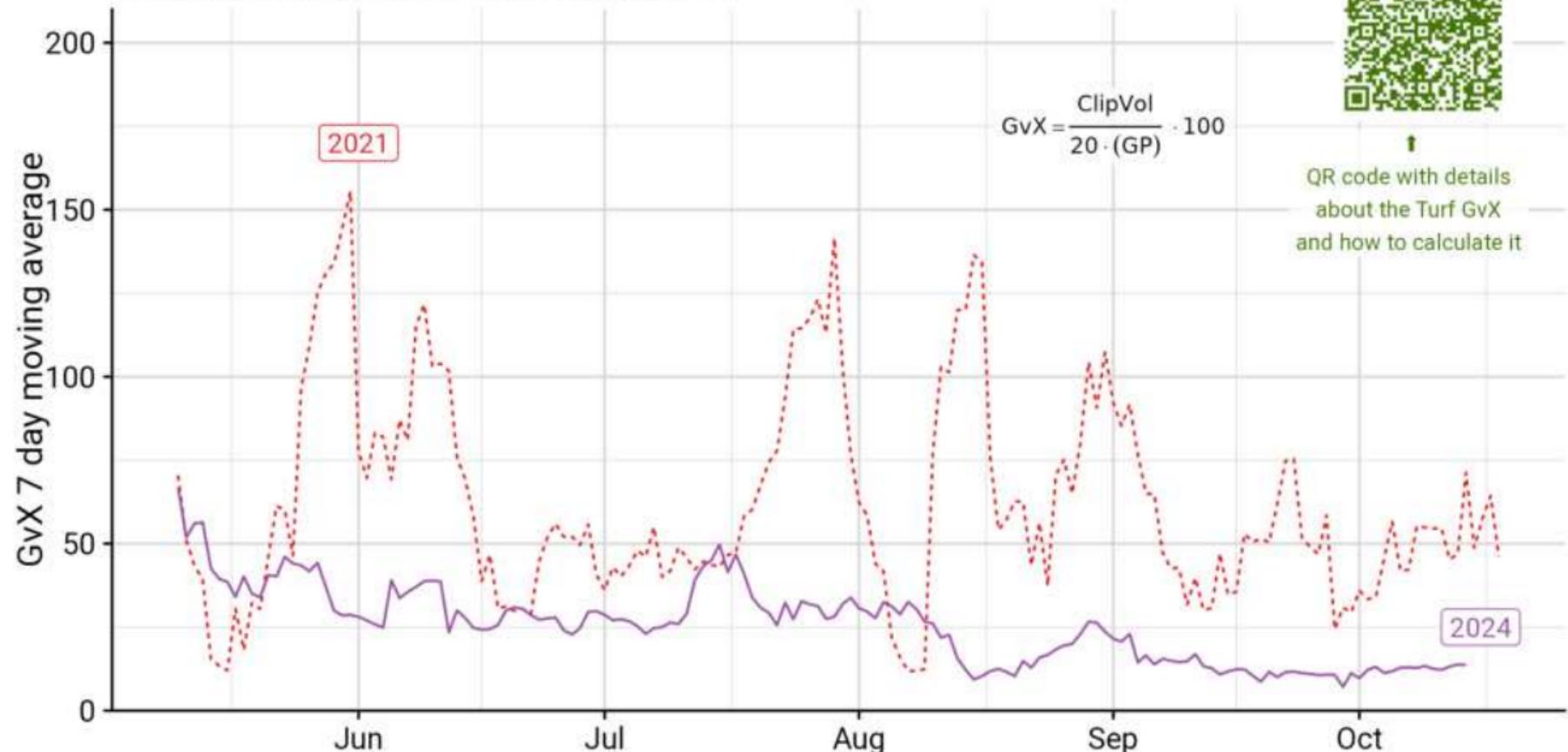
Four years of GvX

Clipping volume adjusted for site temperatures



QR code with details about the Turf GvX and how to calculate it

$$\text{GvX} = \frac{\text{ClipVol}}{20 \cdot (\text{GP})} \cdot 100$$



Data from Penn A-4 creeping bentgrass greens at Hazeltine National GC (Minnesota, USA)





www.asianturfgrass.com

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