# Examining Hybrid Systems

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Iowa State University

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# Injury-Prevention vs. Synthetic Turf

- Only Natural Grass Can Level The NFL's Playing Field (NFLPA)
  - NFL players "have a **28% higher rate** of non-contact lower extremity injuries when playing on artificial turf."
  - "Of those non-contact injuries, players have a **32% higher rate** of non-contact knee injuries on [artificial] turf and a **69% higher rate** of non-contact foot/ankle injuries compared to grass."
- Higher Rates of Lower Extremity Injury on Synthetic Turf Compared With Natural Turf Among National Football League Athletes
  - "Hybrid fields, which incorporate a small percentage of synthetic fibers into a natural turf system, were classified as **natural**."
  - "Play on synthetic turf resulted in **16% increase** in lower extremity injuries per play than that on natural turf."

- Lower Extremity Injury Rates on Artificial Turf Versus Natural Grass Playing Surfaces: A Systematic Review
  - "Football players, particularly those at high levels of competition, were **more likely** to sustain a knee injury on artificial turf than on natural grass."

# The Problem

- The zone of traffic concentration

(Cockerham, 1989)

- Reduces turf cover
  - Increases surface hardness
  - Reduces traction

(Holmes and Bell, 1986)

- **Data collected from 14 professional and college football games**
- **78% of traffic is concentrated on 7% of the field**
- **Max. traffic concentration occurs at the 40 yd line**
- **56 cleat marks $ft^{-2}$**

**Cockerham, S.T. 1989**

# Hybrid Turf Systems: Then and Now

Hybrids now classified as either:

- Permanent= Fibers are sewn into root zone and extend above soil surface into canopy
- Mat system= Fibers sewn into Mat which is secured over soil surface… seeded into

# According to an England Survey

- The majority of footballers (EPL soccer players) prefer the feel and playability of natural turf

- However, it can be inconsistent and difficult to maintain

# World Cup Hybrid History

- The World Cup in South Africa only 2 stadiums used the blend of artificial and real grass
  - This was the first-time artificial turf had appeared in a world cup.

- Artificial turf is used throughout the premiership
  - About two-thirds of the Premier League pitches are now hybrid.

- While many footballers favored the feel of natural turf - which after all had sufficed for the game since its infancy - it was inconsistent, notoriously difficult to maintain and periodically led to "quagmire" pitches.

# 7 of 8 Qatar 2022FIFA World Cup Stadiums

AL Bayt Stadium

Al Thumama Stadium

Ahmed Bin Ali Stadium

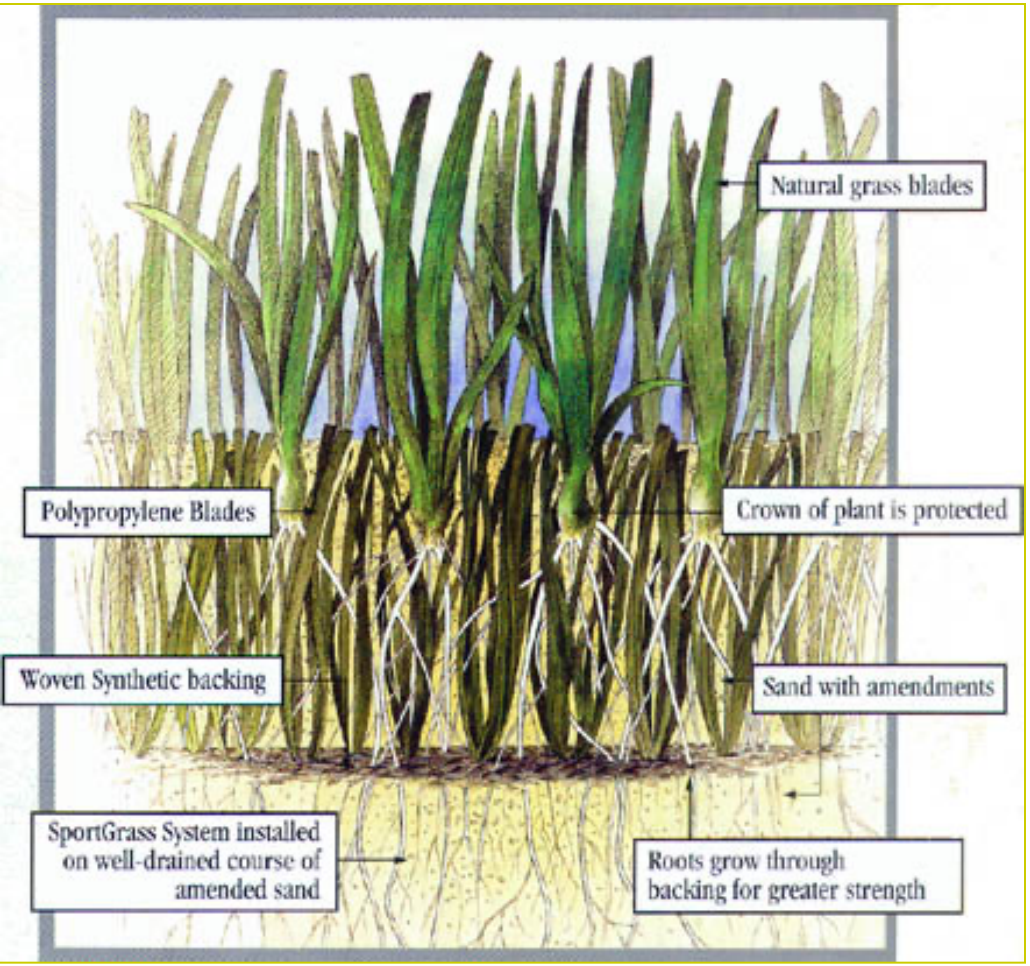
Khalifa International Stadium

Education City Stadium

Ras Abu Aboud Stadium

Janoub Stadium

# SportGrass



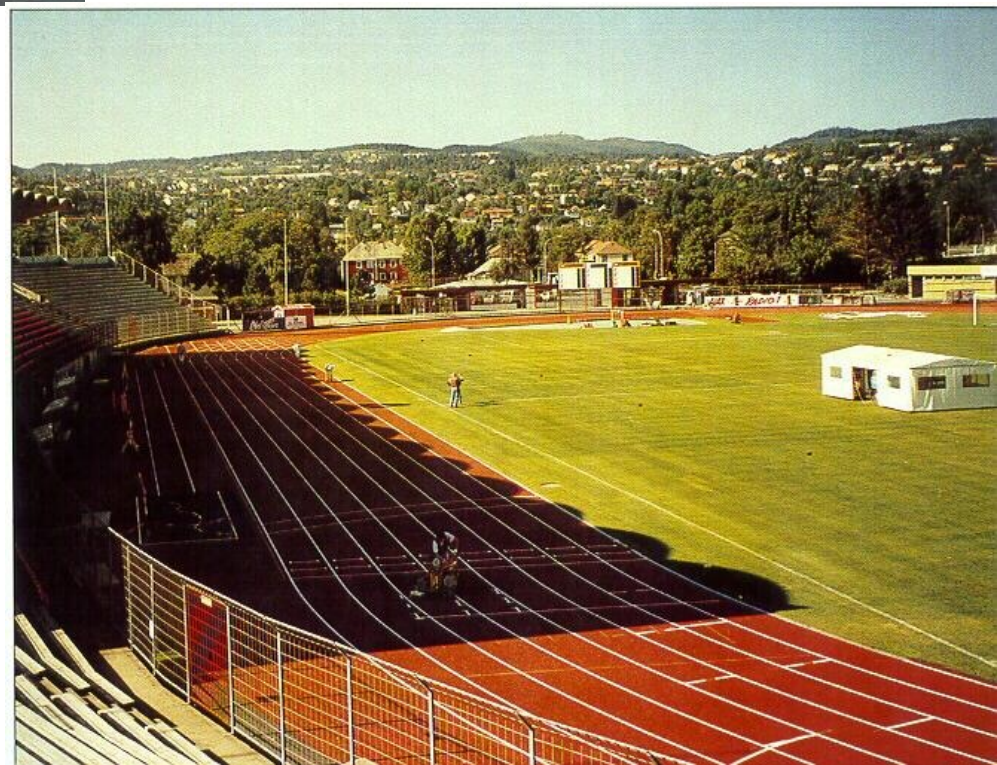

SPORTGRASS®

# TSII (MotzGrass)


# **GrassMaster** (Netherlands)

← GrassMaster Machine

GrassMaster Installation →



# Desso System with Grass Removed

Photo courtesy Mr. Simon Gumbrill - SGL

# Seeding



**Tom Gould**

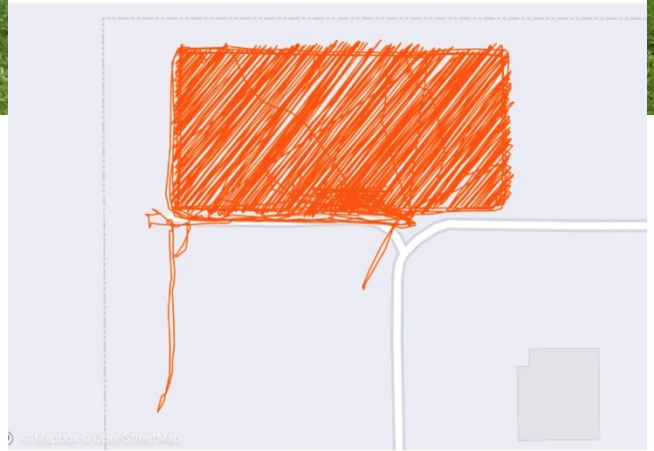
Today at 10:13 AM · Story County, Iowa

## Afternoon Mow

Went the opposite diagonal direction to make some diamonds. Nice and Sunny!

| Distance | Elev Gain | Time |
|---|---|---|
| 15.03 mi | 715 ft | 4h 11m |

**Congratulations, this activity is your longest hike on Strava!**




October 12th


STATE


JACK TRICE STADIUM
CYCLONE MARCHING BAND


September 2, 2022
JACK TRICE STADIUM
IOWA STATE
CYCLONES
STATE
MIDAMERICAN ENERGY FIELD
HOME OF THE CYCLONE MARCHING BAND
CYCLONES

# July 2nd, 2022

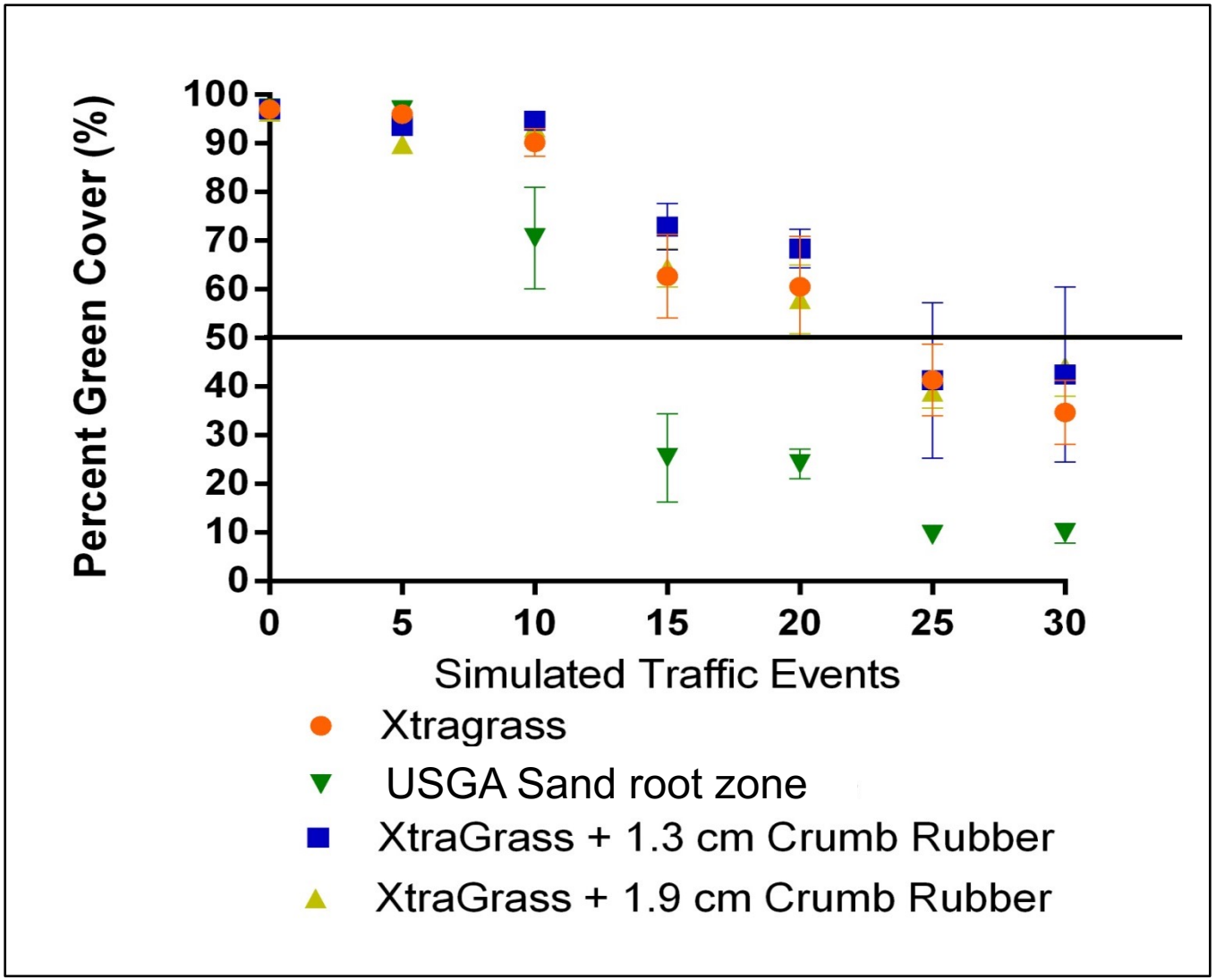
# XtraGrass

Photo Credit: http://www.greenfields.eu/innovation/xtragrass/

# XtraGrass

- Study basics:
  - With and without XtraGrass
  - 2 turf species
    - Kentucky bluegrass
    - Bermudagrass
  - 2root zones
    - Native soil
    - USGA sand based root zone
  - 2 rates of crumb rubber
    - 1.3 cm
    - 1.9 cm

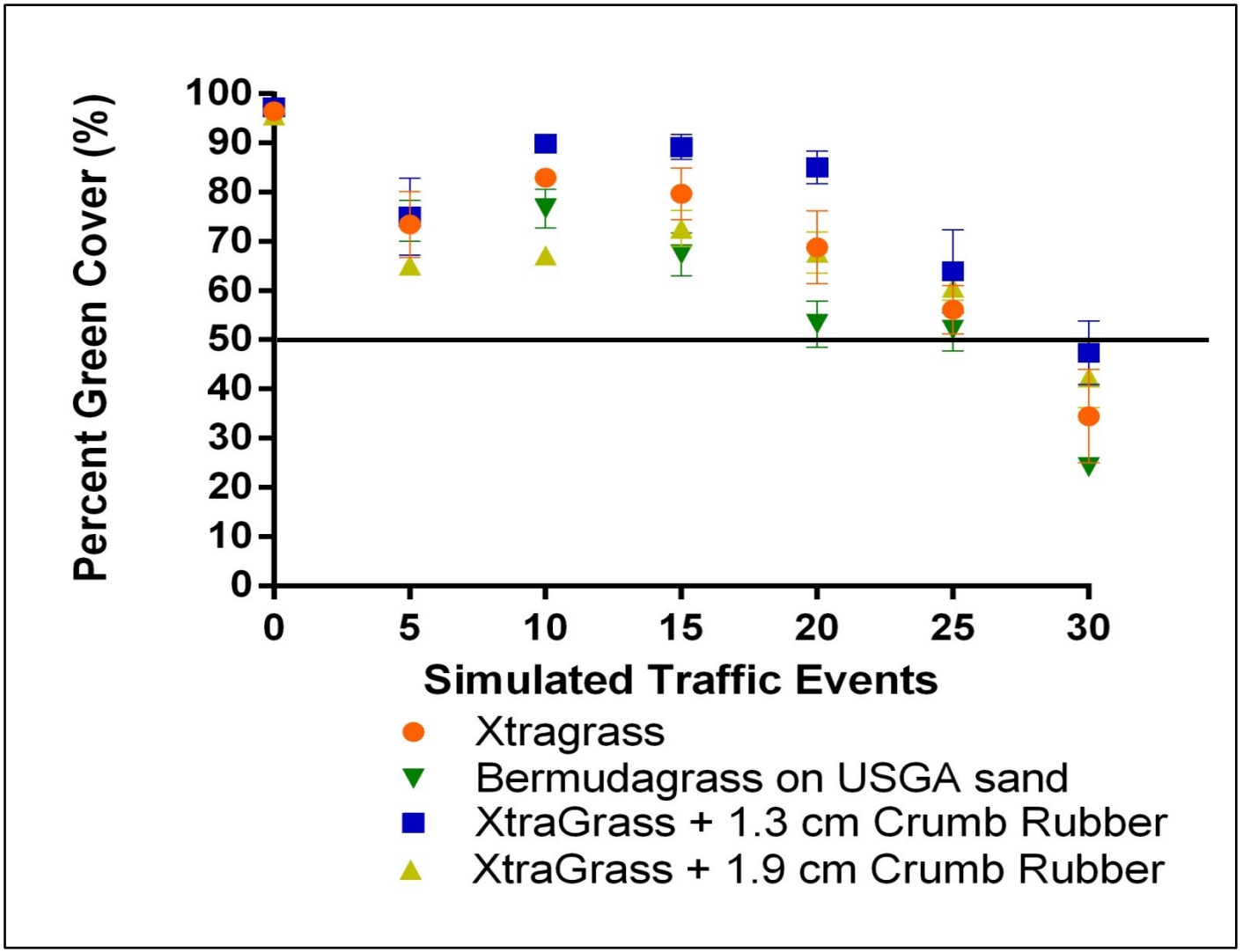
# Kentucky bluegrass over USGA sand



# Surface Hardness Values for USGA Sand

| | 2014 | | | 2015 | | |
|---|---|---|---|---|---|---|
| **Treatment** | 0 games | 15 games | 30 games | 0 games | 15 games | 30 games |
| **KBG only** | 50 | 87 | 80 | 52 | 70 | 56 |
| **KBG + XtraGrass** | 58 | 92 | 88 | 66 | 74 | 66 |
| **L.S.D.** | 4 | 17 | 13 | 9 | 4 | 12 |

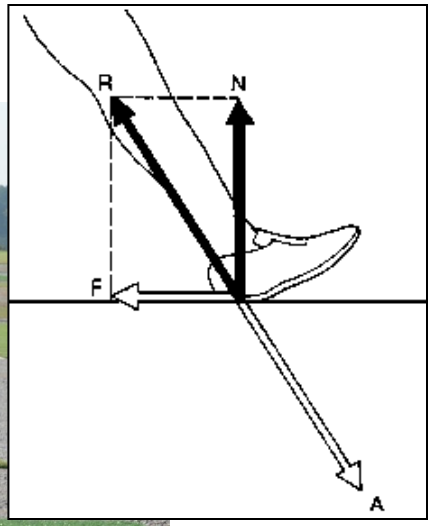
# Bermudagrass grown over USGA sand



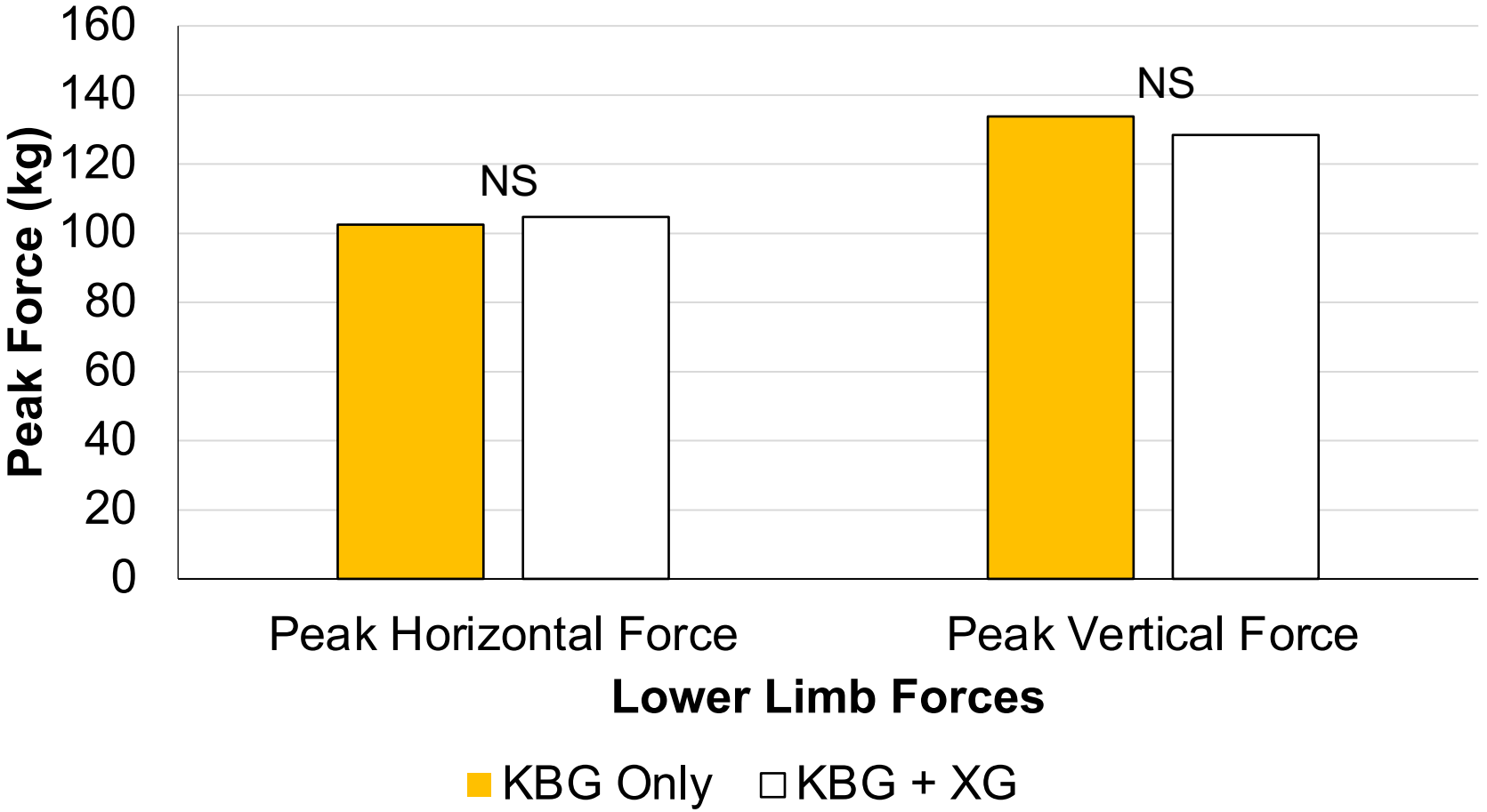
# Surface Hardness Values for USGA Sand

| | 2014 | 2015 |
|---|---|---|
| Treatment | GMAX 30 games | GMAX 30 games |
| Bermudagrass Only | 88 | 81 |
| Bermudagrass + XG | 99 | 92 |
| LSD (0.05) | 10 | 10 |

# Tennessee Athletic Field Tester

# Peak Lower Limb Forces



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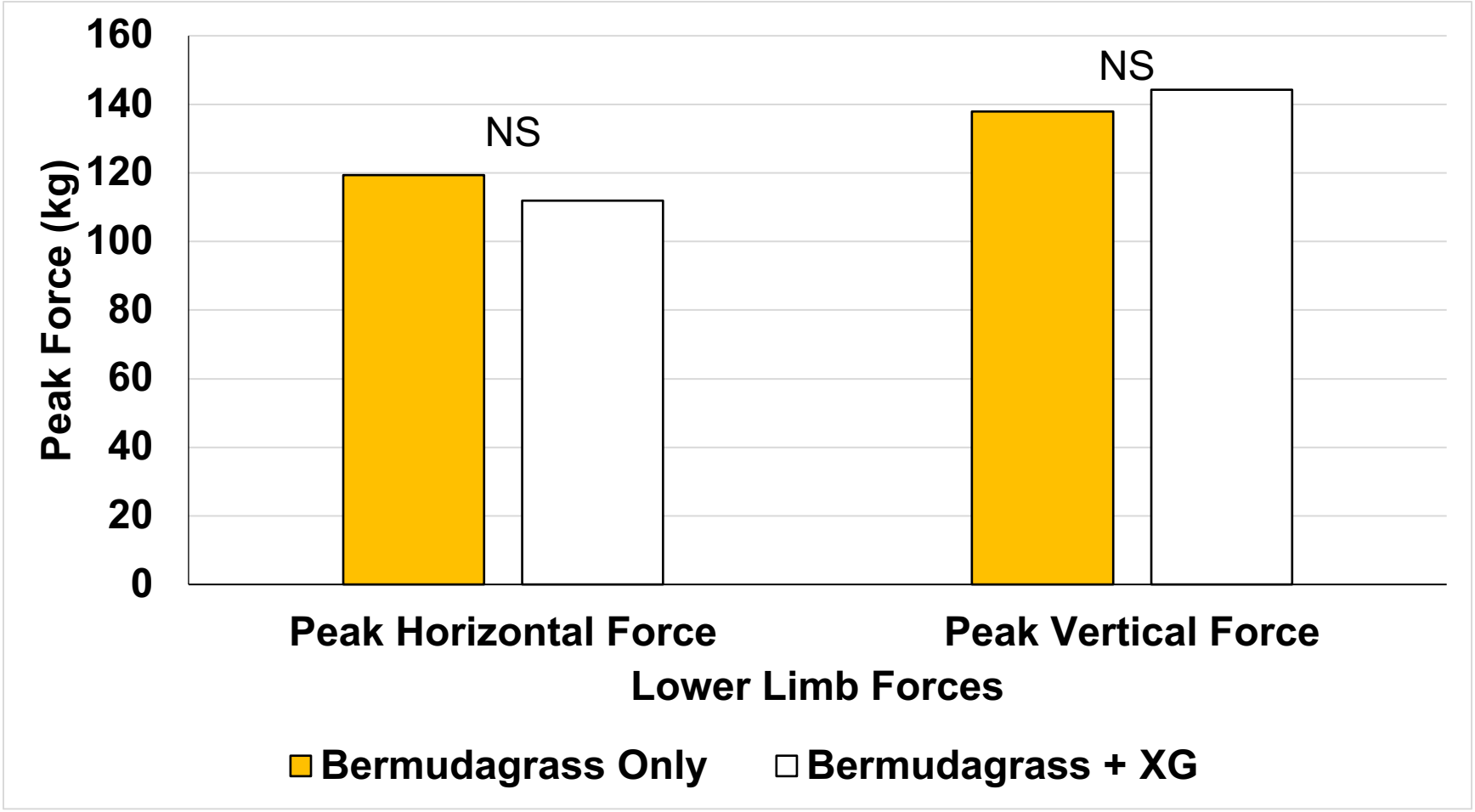


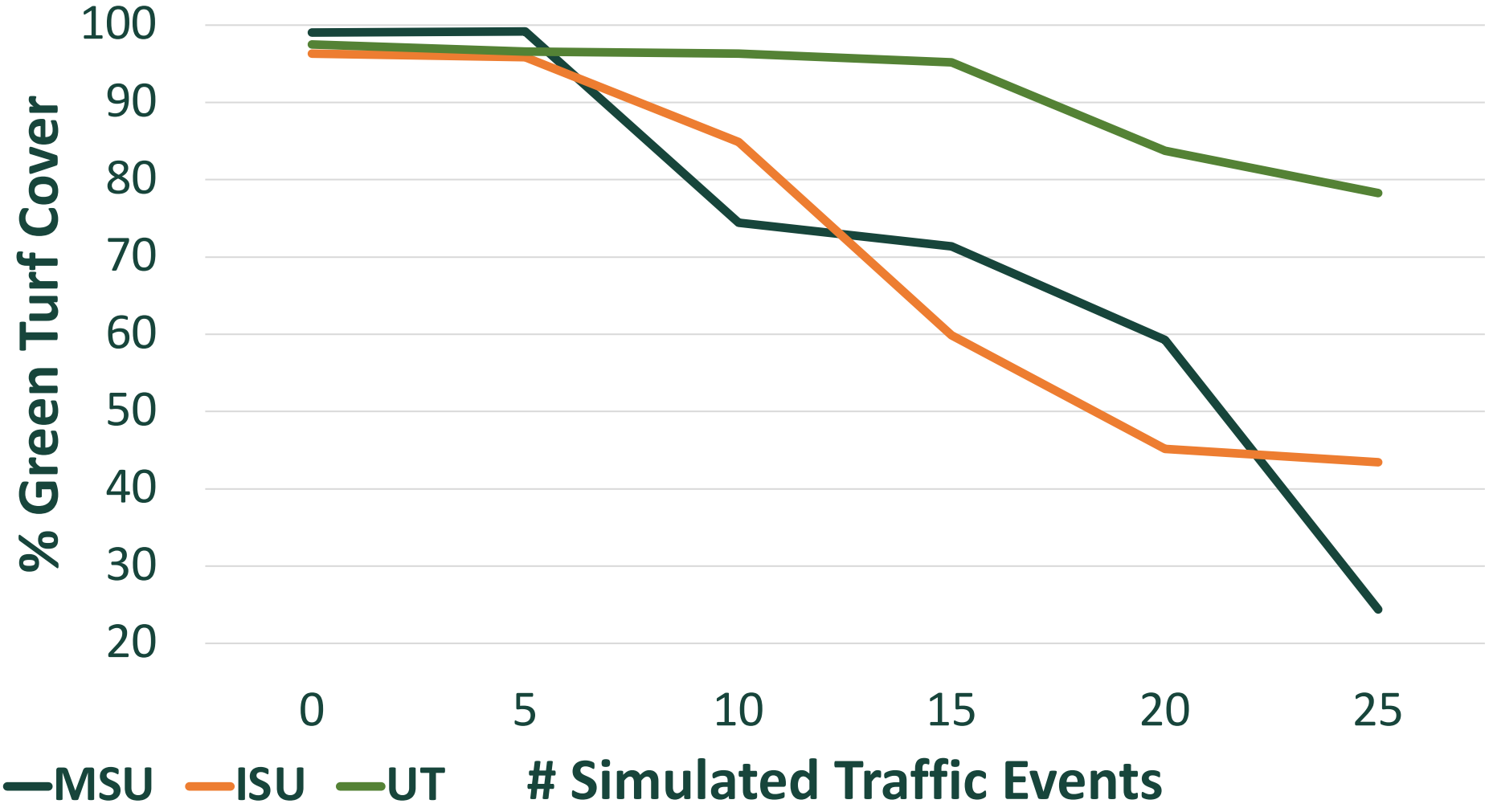
# New Hybrid Turf Systems

- Multi-state study:
  - Iowa State University
  - Michigan State
  - University of Tennessee
- Heat tolerant bluegrass at all locations
- Traffic starts in May/June
- Three treatments:
  - Slit film fibers + natural turf
  - Monofilament + natural turf
  - Natural turf only

# Motzgrass Mat Hybrid Systems: Hero and Eclipse LP

- Permeable mat with two backings:
  - Permanent (holds fibers)
  - Bio-degradable (self-explanatory)
- Natural turf roots grow through
- Stabilizes playing surface
- Can be cultivated each season for “renewed” surface


Weekly change in % green turf cover of three turf systems following 25 simulated traffic events *between* three testing locations—Fall, 2018

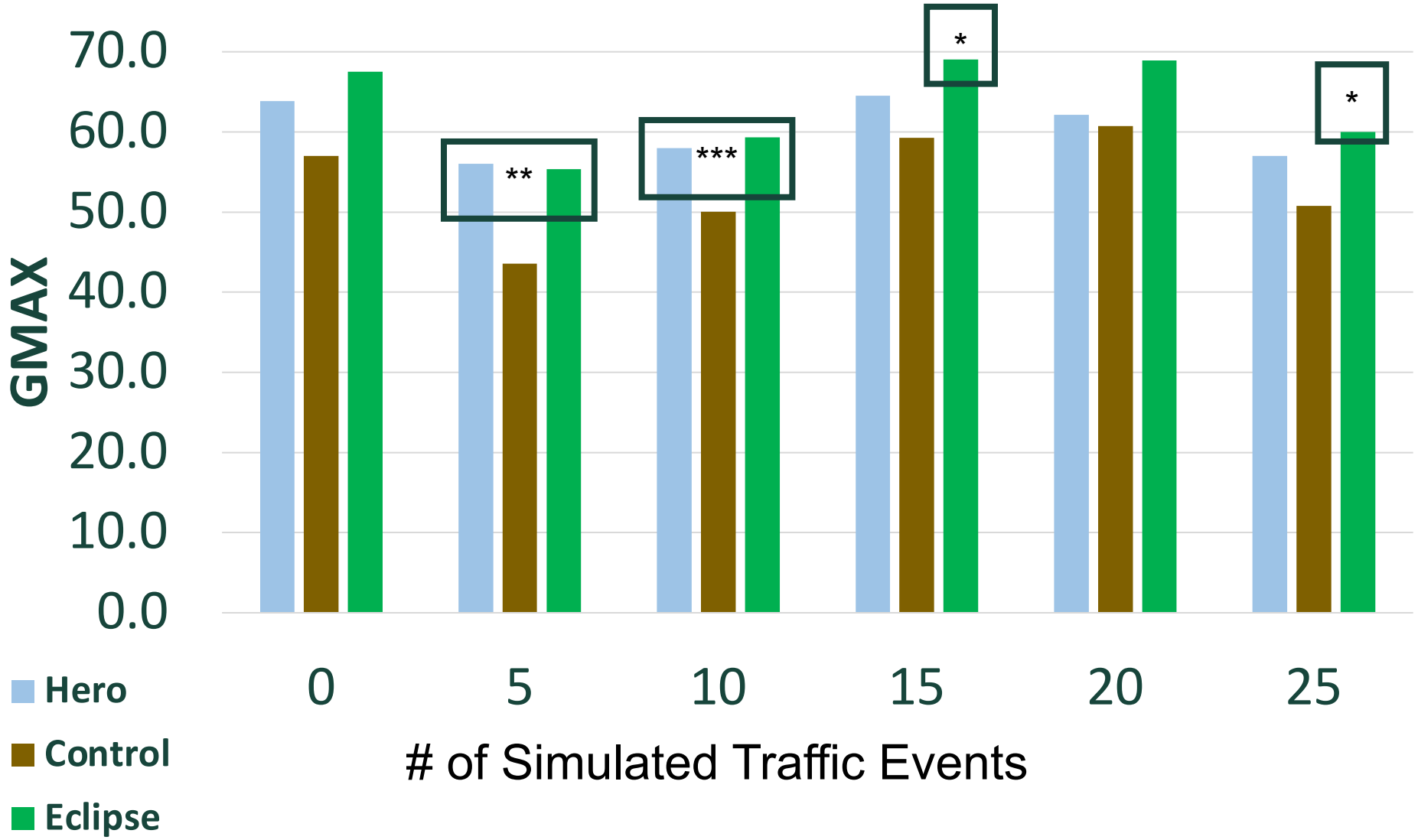


# RESULTS… SEE THE DIFFERENCE?!

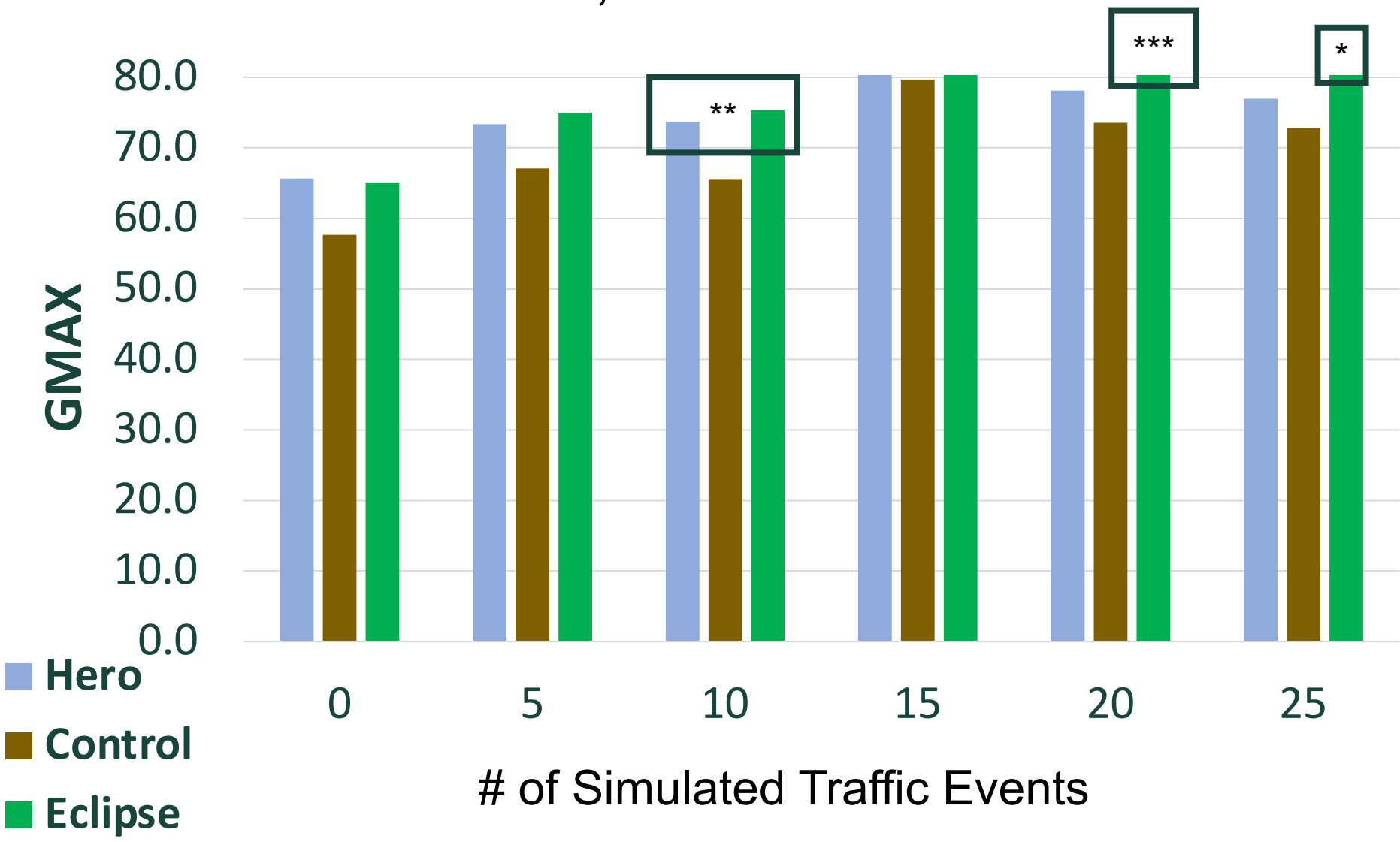




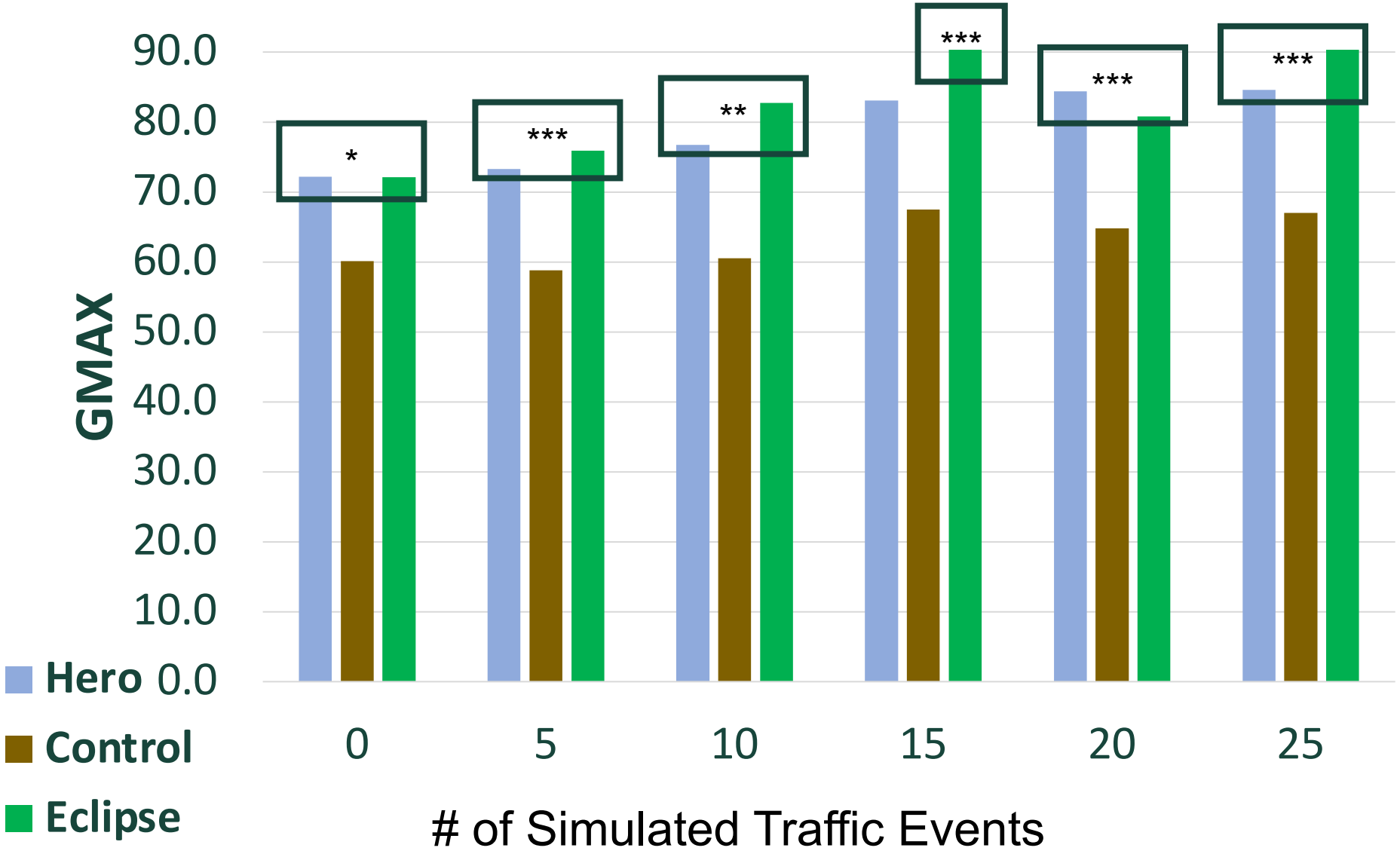

# Change in surface hardness (GMAX) of two hybrid turf systems vs. control, following 25 simulated traffic events, East Lansing, MI—Fall 2018



# Change in surface hardness (GMAX) of two hybrid turf systems vs. control, following 25 simulated traffic events, Ames, IA—Fall 2018



Change in surface hardness (GMAX) of two hybrid turf systems vs. control, following 25 simulated traffic events, Knoxville, TN—Fall 2018



# Conclusions

- Change in green turf cover between hybrid systems was insignificant @ each site
- Cumulative reductions in green turf cover significantly reduced across locations and time
- Peak surface hardness for the Eclipse LP system was highest of all systems after:
  - 5, 10, 15 & 25 simulated traffic events (**MSU**)
  - 10, 20 & 25 simulated traffic events (**ISU**)
  - All simulated traffic events (**UT**)
- Between the control and both hybrid systems evaluated, the Eclipse system achieved significantly greater surface hardness across all locations and time

# The Innovation

- Launched in June 2015
- Fastest and most accurate installation available
- Artificial fibre correlates with natural grass
- Improved surface stability
- Many more hours of play
- 95% Natural grass surface

SIS Grass

SIS Grass

- Unique ability to stitch at **different depths and spacings** depending on client requirements and budget
- **Premium polyethylene fibres** – looks and feels like natural grass
- **Innovative machines** – 100% electric in a variety of sizes
- **Fastest installation** on the market – up to 4 x faster than other providers

# Electric Machines

Laser guided technology

Designed and manufactured in the Netherlands

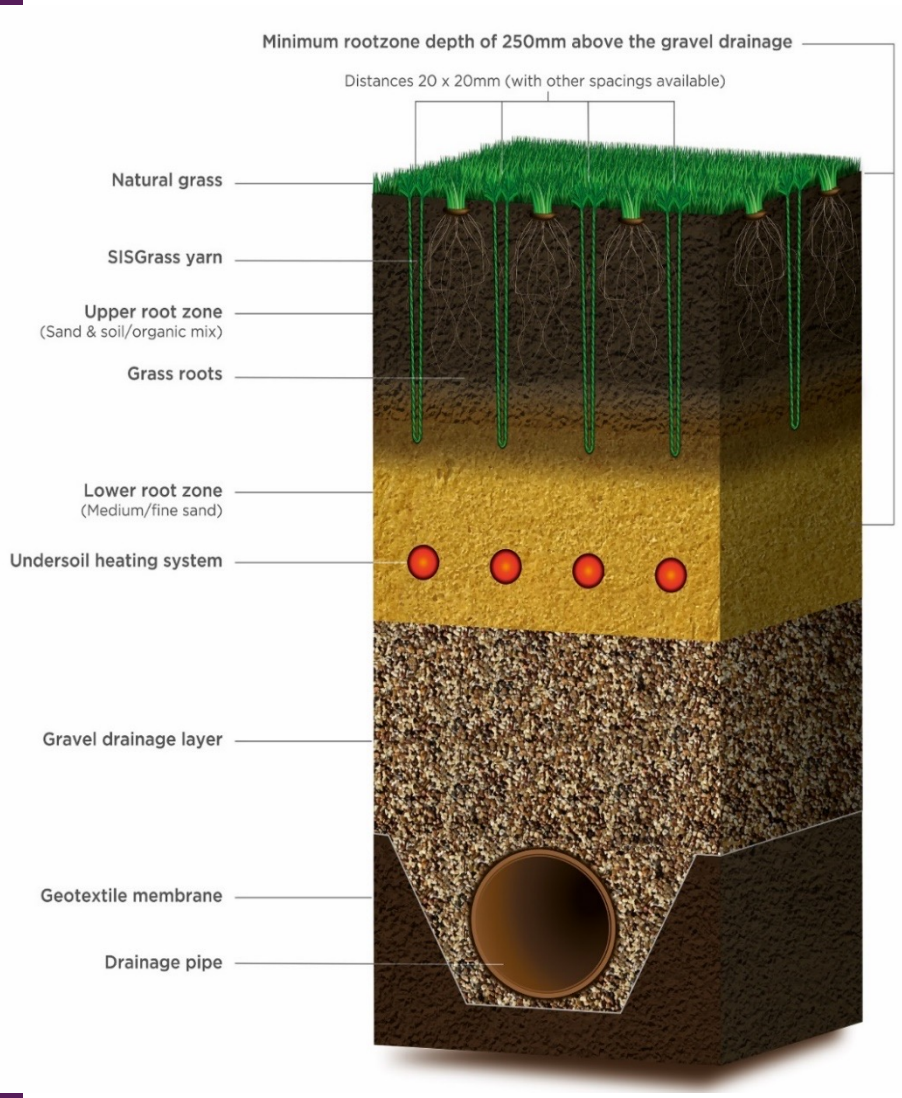


SIS Grass

# Cross Section

- Fibres inserted 90 or 180mm into the rootzone.
- 20mm of fibre above the surface.
- Upper rootzone

  10 – 20% soil / organic mix.



- **Two-tone** – natural in appearance.
- **UV Stable** – will not fade or lose structural integrity over time.
- Tested at the **STRI** for stability & influence on the performance of the natural grass surface.
- Excellent **recovery** during renovation.
- **50% more yarn** by weight than other systems.
- **9,000kg** of yarn installed for a 7,500m2 pitch.
- **8 Year** warranty.

# 100% ELECTRIC MACHINE

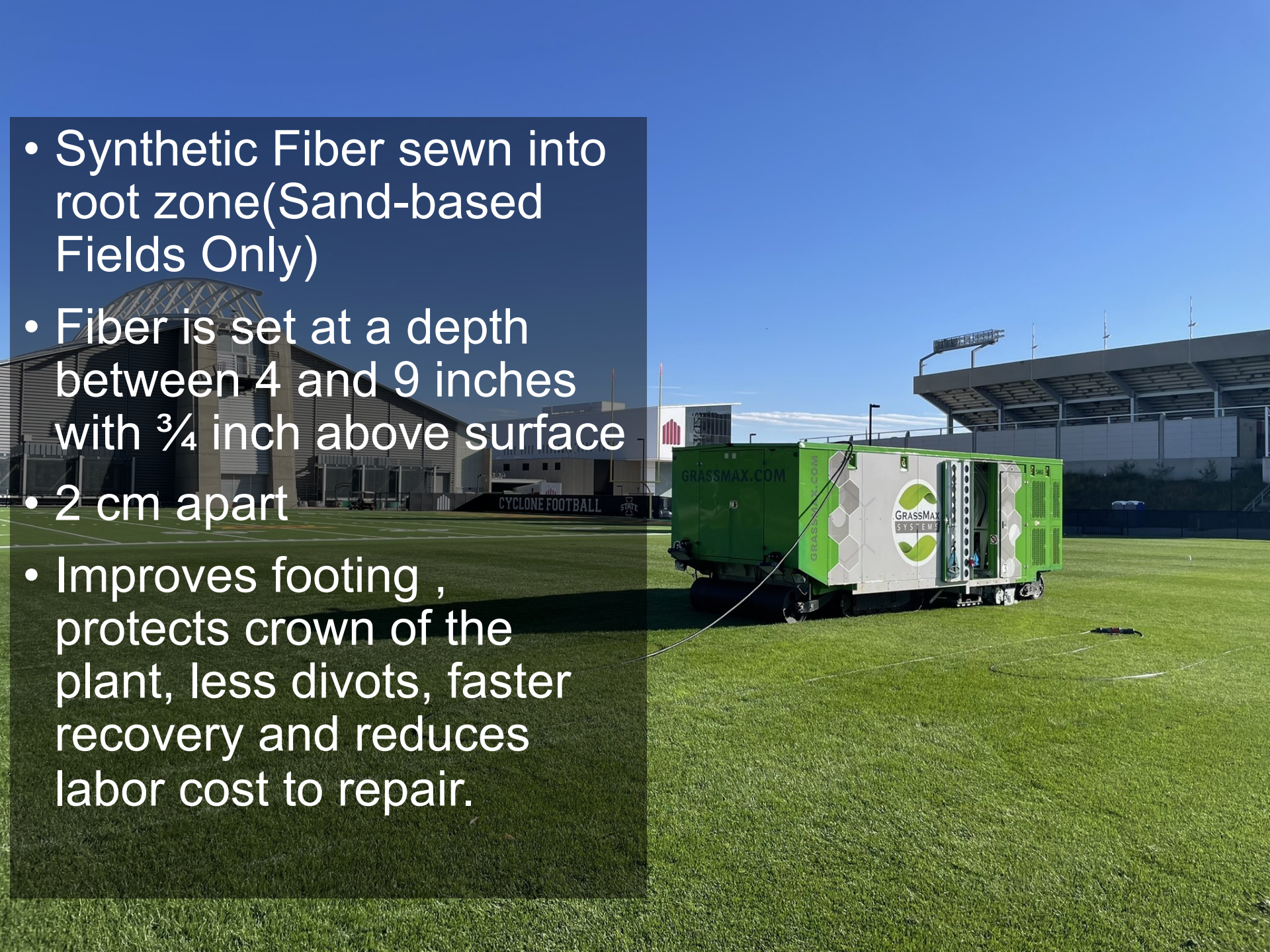
- Stitch a full-size football pitch in just 7 days using electricity
- Only machine of this size and patented technology on the market with 100% electric technology
- More efficient, quicker and quieter operation
- Fluid Free with No risk of damaging oil leaks


# *RENOVATION*

- Successful renovations are key to the **longevity** and ongoing **performance** of all hybrid pitch surfaces

- SISGrass provides **unrivalled fibre recovery** during renovation proven over the past five years

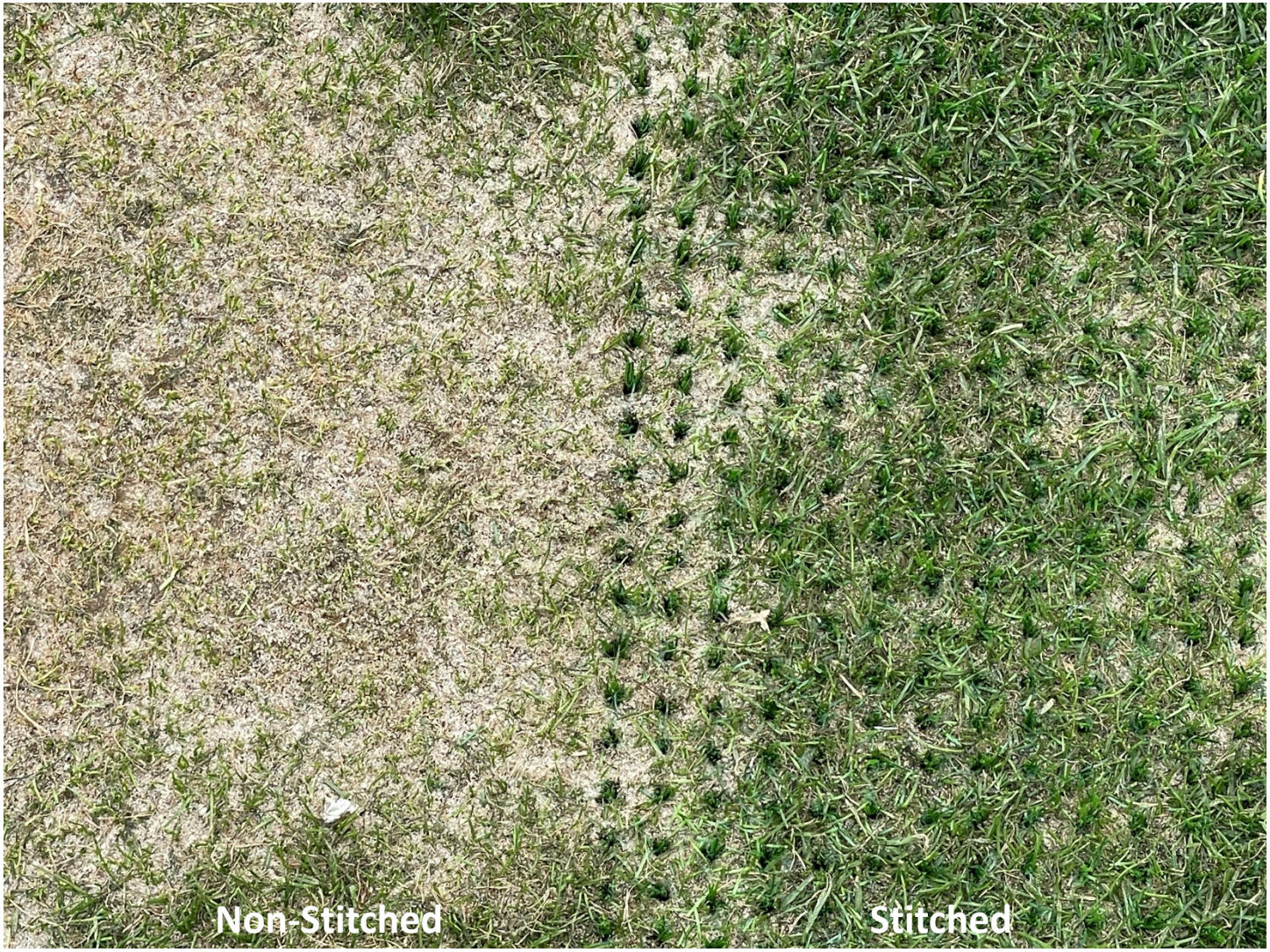
- **Consistent** and **clean** surface with no loss of fibre.




- Synthetic Fiber sewn into root zone(Sand-based Fields Only)
- Fiber is set at a depth between 4 and 9 inches with ¾ inch above surface
- 2 cm apart
- Improves footing , protects crown of the plant, less divots, faster recovery and reduces labor cost to repair.


Jack Trice Stadium Before


Jack Trice Stadium After


Non-Stitched
Stitched

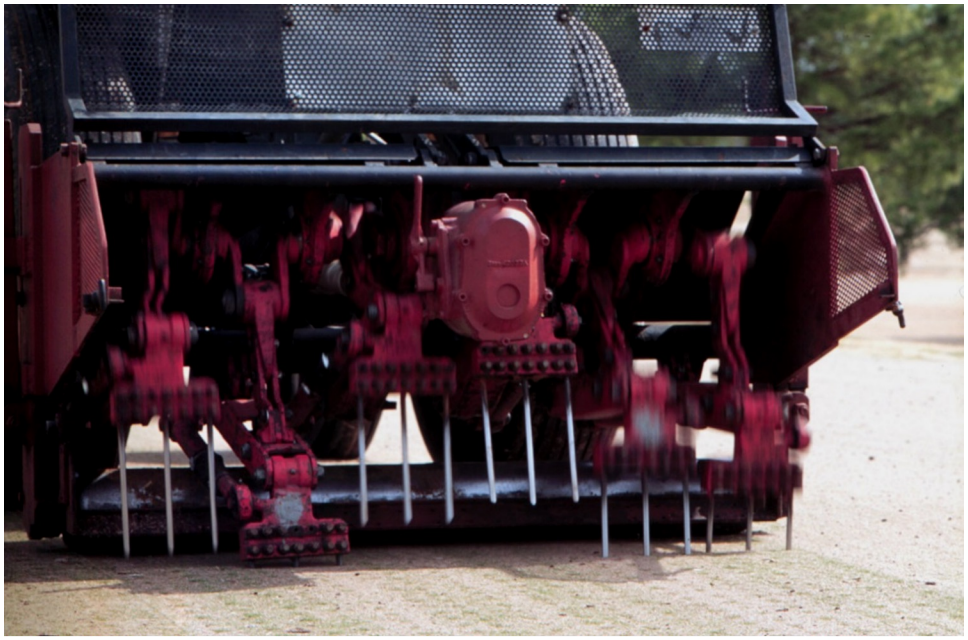

JOHNNY MAJORS
PRACTICE FIELD


STATE
HyVee


CYCLONES

# Hollow-Tine Cultivation

# Sand topdressing




Solid-tine aerifier

# Vertical Mowing


Raking Hybrid Systems
Photo courtesy Mr. Simon Gumbrill - SGL


# Brush Cartridge on Allett Mower

# Fraze Mowing System

# XtraGrass after Fraze Mowing

# Questions???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# Comparing Bermudagrass to Synthetic Turf and Kentucky Bluegrass

# Surface Hardness


# Surface Hardness

- Ground Reaction Forces
  - The force exerted on an athlete by the surface upon impact

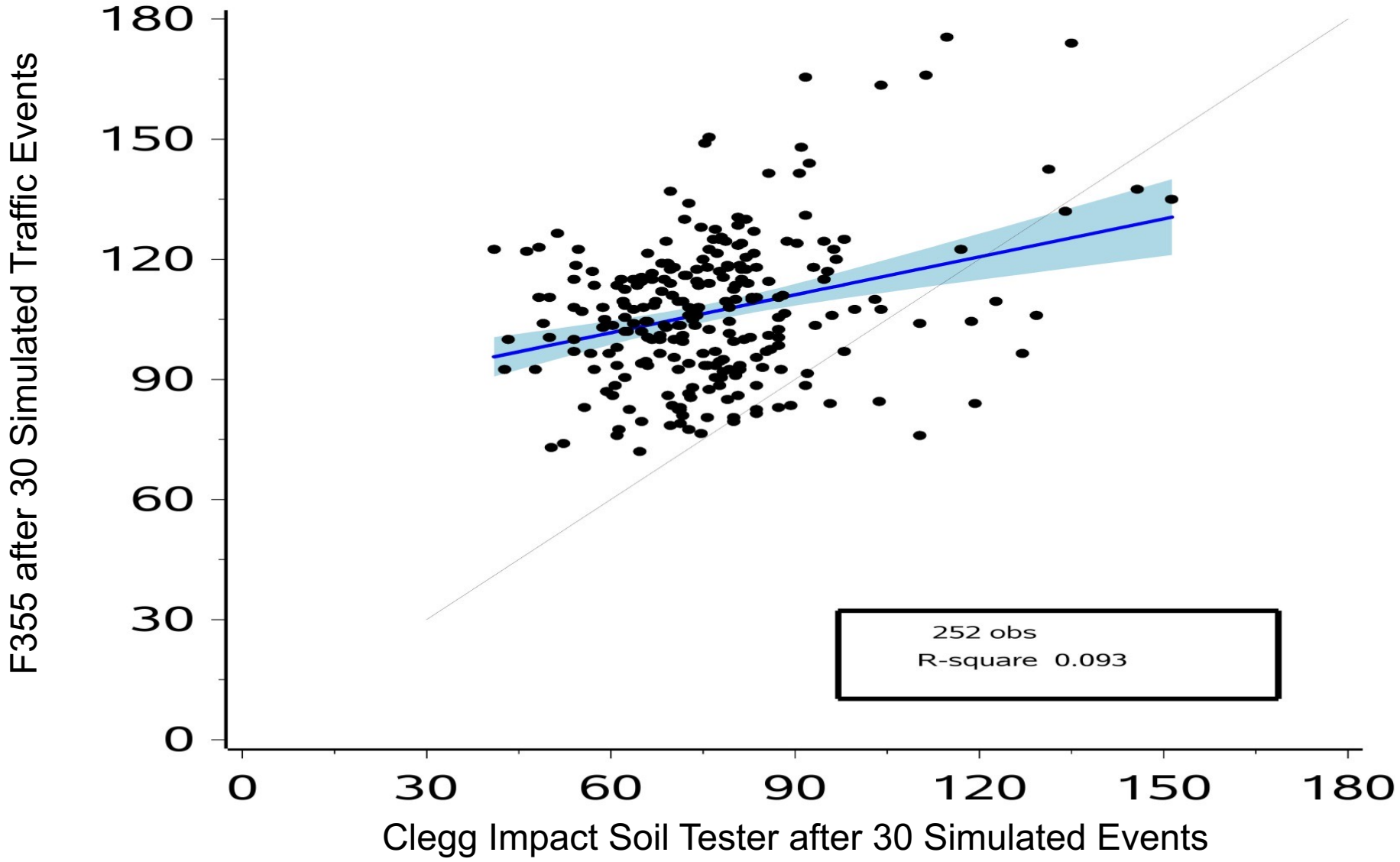
(Elftman, 1938; Nigg et al., 1984; Brosnan, 2007)

# Clegg & F355 Impact Soil Tester

# Performance and Safety of Athletic Fields

# Performance Evaluations

# F355 to Clegg Relationship



# Tennessee Athletic Field Tester

Thoms et al., 2012, 201

# Force Measurements

| Effect | Rotational Resistance | TAFT Horizontal Force | TAFT Vertical Force |
|---|---|---|---|
| Root zone (R) | NS | NS | NS |
| Traffic Rate (TR) | *** | NS | NS |
| R by TR | * | NS | NS |

***,* Significant at 0.001, 0.05 probability level, respectively.
NS, not significant at P ≤ 0.05.

# F355 Comparisons

## Synthetic Turf = Bermudagrass > KBG

**9.1 kg missile**
**61 cm drop height**

# Clegg Surface Hardness Comparisons

**Synthetic Turf > Bermudagrass > KBG**

**2.25 kg missile**
**45 cm drop height**

# Rotational Resistance Comparisons

## Synthetic Turf = Bermudagrass = KBG

# TAFT Horizontal Comparisons

## Synthetic Turf > Bermudagrass > KBG

# TAFT Vertical Comparisons

## Synthetic Turf > Bermudagrass > KBG


# Temperature on Synthetic Turf

# Surface Temperature


**Reported Infilled surfaces :**

- 150 °F (Lim and Walker (2009)
- 167 °F (De Vitt et al. 2007)
- 194 °F (Williams and Pulley, 2006)

**Reported non-infilled surfaces:**

- 95 to 140 °F (Buskirk et al. 1971)

White lines and shaded areas are cooler (Williams and Pulley, 2006)

# Effect on Athletes

- Heat transfer from the surface to the inner soles of  shoes could result in heat-related illnesses

Buskirk et al. 1971

# Irrigation & Synthetic Turf

(Williams and Pulley, 2002; McNitt et al. 2008)

# Research Objective:

Build a model to predict synthetic turf surface temperature using forecasted atmospheric data

# Statistical Analysis

- Data collected during three time segments:
  - 22 August to October 2011
  - 14 February to 12 April 2012
  - 25 May to 27 July 2012

- Multivariate linear regression ($\alpha$=0.05) in Minitab
  - Determine what atmospheric parameters could be used to predict daily minimum, maximum, and mean synthetic turf surface temperature
  - Models offering highest $R^2$ values selected for further evaluation

# Surface Temperature Results

- Surface temperature range: 30 to 187°F at ambient air temperatures of 31 to 99°F
- Surface temperatures differed less than 6° C among surfaces
- 98% of  solar radiation falls within the middle ultraviolet (200 to 315 nm) to near infrared spectrum (720 nm to 0.00015 cm) (Robinson 1966)
- High solar radiation was likely the driving force behind increased surface temperature

# Synthetic Turf Models

| Synthetic Turf Surface Temperature Model | $R^2$- value |
|---|---|
| Maximum Temperature = -10.25 + (1.622*Max forecasted air temperature °C) + (0.023*Max forecasted solar radiation W/m$^2$) | 0.87 |
| Mean Temperature = 0.58 + (0.948 *Mean forecasted air temperature °C) + (0.035 * Mean forecasted solar radiation W/m$^2$) | 0.95 |
| Minimum Temperature = -0.73 + (0.98 *Minimum forecasted air temperature °C) | 0.94 |

# Questions???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