DATA AND DECISIONS

Applying Research in Sports Field Management Practices

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"Be Your Own Scientist!"

- **Gerald Henry**, PhD
University of Georgia
2023 SFMA Conference

WHY?

- Turfgrass management is an art … and a **SCIENCE**
- Enhance **PROFESSIONALISM**
- **ENVIRONMENTAL** Stewardship
- Fiscal **RESPONSIBILITY**

Sports Field Managers Have To Make **MANY DECISIONS!**

HOW?

... can Sports Field Managers Enhance Their Decision-Making?

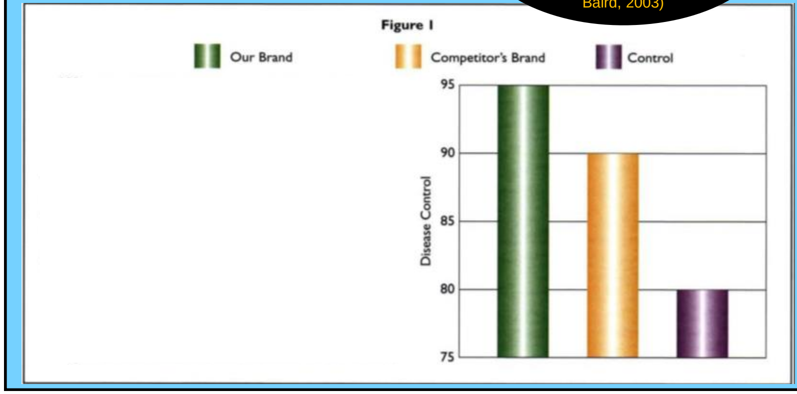
DATA and DECISIONS

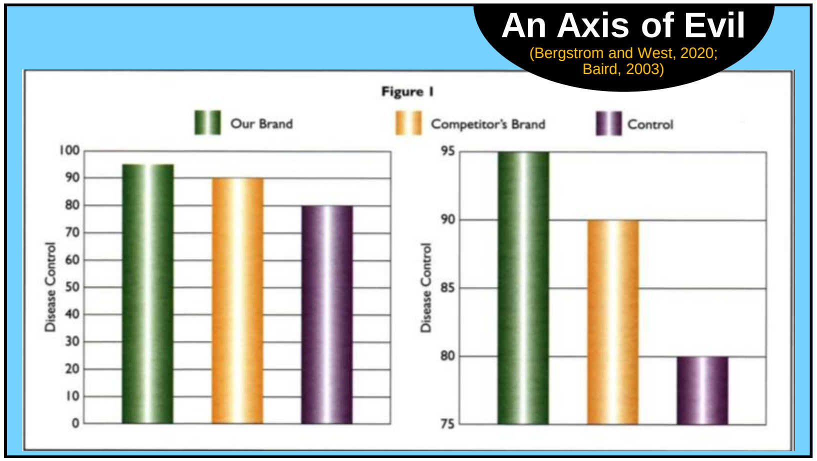
- Don't be afraid to ask **QUESTIONS**
- Use data to **INFORM** decisions
- Apply **SCIENTIFIC** findings
- Conduct your own **RESEARCH**

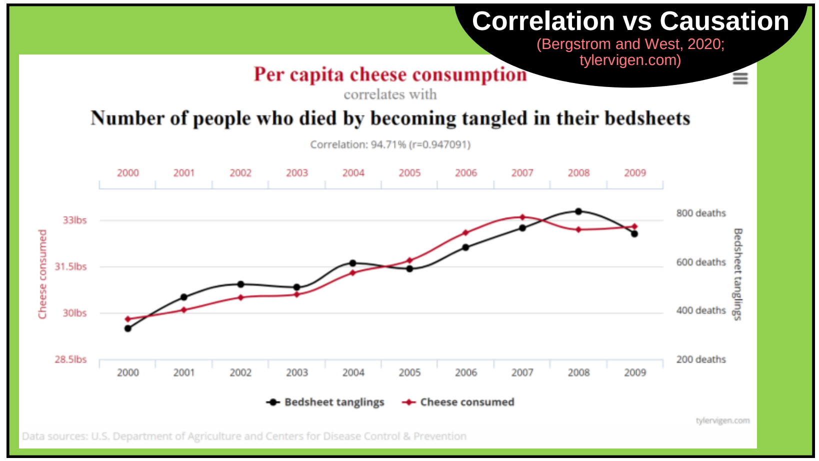
ASK QUESTIONS!
(Carrow, 2000)

- Is this product even **necessary**?
- Are there better **alternatives**?
- Is this **response** actually from the active ingredient?
- What about the **impact**, **duration**, and **consistency** of the response?
- Are there objective, **published research findings** available?
- Could I first **try** this on a **trial basis**?
- Do the benefits **justify the costs**?

An Axis of Evil
(Bergstrom and West, 2020; Baird, 2003)




An Axis of Evil
(Bergstrom and West, 2020; Baird, 2003)
Figure 1
Our Brand
Competitor's Brand
Control
Disease Control
100
90
80
70
60
50
40
30
20
10
0
Disease Control
95
90
85
80
75


Correlation vs Causation
(Bergstrom and West, 2020; tylervigen.com)
Per capita cheese consumption
correlates with
Number of people who died by becoming tangled in their bedsheets
Correlation: 94.71% (r=0.947091)
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
Cheese consumed
33lbs
31.5lbs
30lbs
28.5lbs
Bedsheet tanglings
800 deaths
600 deaths
400 deaths
200 deaths
Bedsheet tanglings
Cheese consumed
tylervigen.com
Data sources: U.S. Department of Agriculture and Centers for Disease Control & Prevention

Selection Bias

(Bergstrom and West, 2020)

"This product is guaranteed to increase nitrogen uptake by ___ %"

"This cultivar requires _____ % less pesticide / fertilizer / water ..."

COMPARED TO WHAT???

WHY?

... is it important to utilize research-based evidence ?

The Scientific Method

1. Observations, Hypotheses, and Objectives
2. Experimental Design and Treatment Protocols
3. Data Collection and Analysis
4. Important Applications for Practitioners

The Scientific Method

Observation

- You have questions

Observation

- Genuine Curiosity
- “Surprise Accidents”
- Difficult Challenges
- Required Alternatives


John Mascaro's Photo Quiz

Answer on page 39

John Mascaro is President of Turf-Tec International

Can you identify this sports turf problem?

Problem: Worn out turf next to the yard lines

Turfgrass area: Varsity practice football field

Location: Weston, Massachusetts

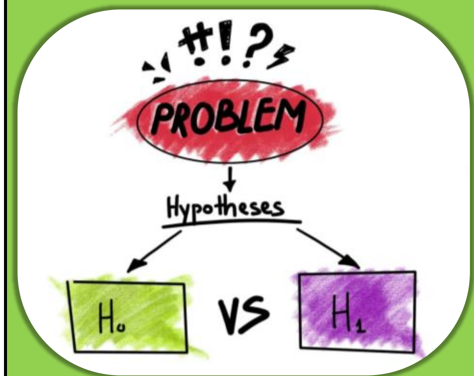
Grass variety: Kentucky bluegrass/ryegrass mix

The Scientific Method

Observation
- You have questions

Hypothesis Testing
- Relationships and impacts

Hypothesis Testing



- Assumptions
- Relationships
- Likelihood

The Scientific Method

Observation
- You have questions

Hypothesis Testing
- Relationships and impacts

Research Objective
- Improved understanding → better decision-making

Research Objectives

- Fill the knowledge gap
- What questions need answered?
- Make better decisions

The Scientific Method

Materials
- Required resources

Methods
- Sound protocols

Materials and Methods

- Experimental area
- Treatment application equipment
- Data-collection technologies
- Software
- Personnel
- Funding
- Time


FRONT NINE

How much does turfgrass research cost?

Watkins (2020) How much does turfgrass research cost?

Materials and Methods

- **Sound** and **justifiable** protocols:
  - Maintenance philosophy
  - Application intensity and frequency
  - Sampling procedures
  - Data collection
  - Be diligent of your time!
- Comparisons against an **untreated control**
  - e.g., UTC

The Scientific Method

Materials
- Required resources

Methods
- Sound protocols

Experimental Design
- Randomization and replication

Experimental Design
(Davis et al., 2017)

- **Completely-Randomized Design**

UTC	TRT C	UTC	TRT B
TRT B	UTC	TRT A	TRT C
TRT A	TRT C	TRT B	TRT C
TRT B	TRT A	TRT A	UTC

- How many treatments?
- How many replications?

Experimental Design
(Davis et al., 2017)

- Completely-Randomized Design
- **Randomized Complete-Block Design**

Rep 1	Rep 2	Rep 3	Rep 4
UTC	TRT C	TRT A	TRT B
TRT A	UTC	TRT D	TRT A
TRT B	TRT D	UTC	TRT C
TRT C	TRT A	TRT B	UTC
TRT D	TRT B	TRT C	TRT D

- How many treatments?
- How many replications?

Experimental Design
(Davis et al., 2017)

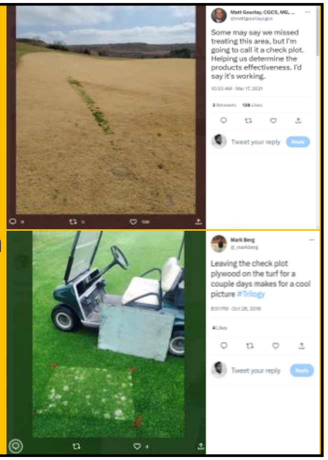
- Completely-Randomized Design
- Randomized Complete-Block Design
- **Split-Plot Design**

Rep 1	UTC MH1	TRT C MH1	TRT A MH1	TRT B MH1
	TRT B MH2	UTC MH2	TRT C MH2	TRT A MH2
Rep 2	TRT A MH2	TRT B MH2	UTC MH2	TRT C MH2
	TRT C MH1	TRT A MH1	TRT B MH1	UTC MH1
Rep 3	UTC MH1	TRT B MH1	TRT A MH1	TRT C MH1
	TRT B MH2	UTC MH2	TRT C MH2	TRT A MH2

- How many treatments?
- How many replications?

Experimental Design

- Completely-Randomized Design
- Randomized Complete-Block Design
- Split-Plot Design
- **Check-Plot Design**



Experimental Design

Straw et al.

https://doi.org/10.1080/17461391.2018.1457083

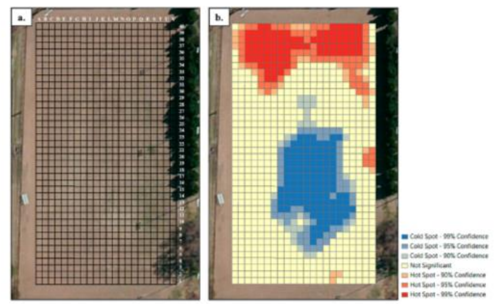


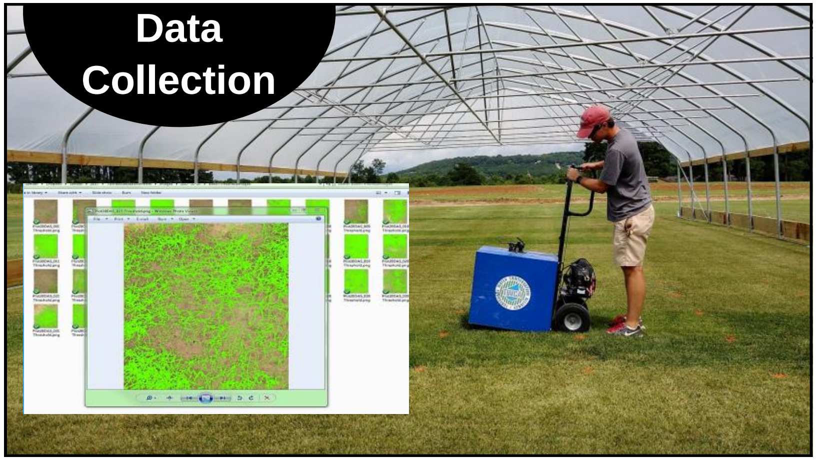
Figure 1. Illustration of (a) the geo-referenced alphanumeric grid (3 m^2 cells) that was provided to athletes in questionnaires to report where injuries occurred on the field (corresponding letter and number signs hung along a fence in the fields) and (b) a hot spot map (red and blue cells represent significantly high and low values within the field, respectively, and yellow cells are considered "average" values).

The Scientific Method

Data Collection
- Measured observations

Data Analysis
- Statistical comparisons

Data Dissemination
- A multitude of mediums


Data
Collection

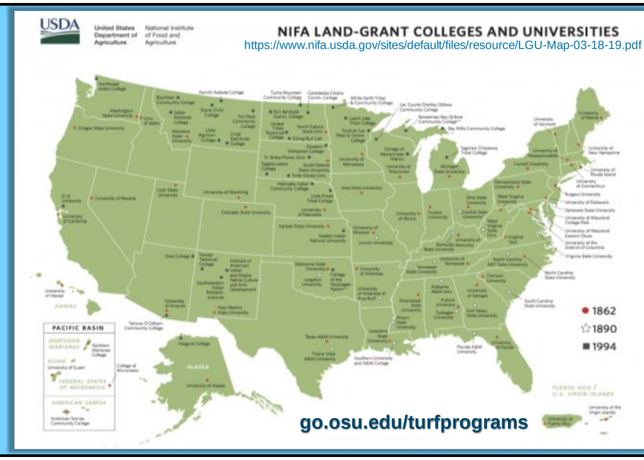

Data
Collection

Data Analysis

Collaboration

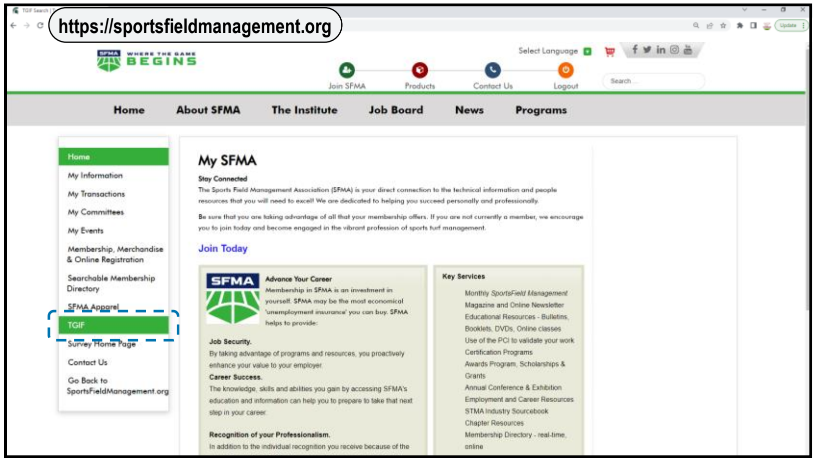
- **PARTNER** with university researchers
- Develop **well-defined** research objectives

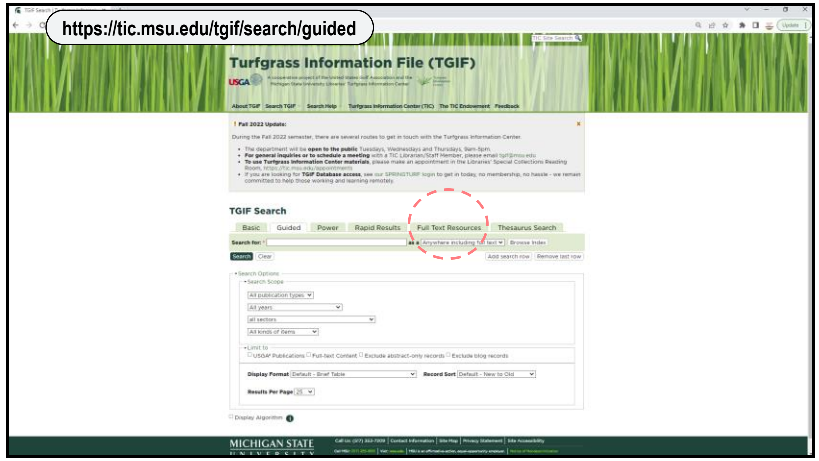
SAFE
The Foundation for Safer Athletic Fields




Data Dissemination
SportsField MANAGEMENT
Podcast
Agronomy
Crop, Forage & Turfgrass Management
Crop Science
Virginia TURFGRASS
A Collaborative On-Site Research Project Between
Kansas State University
SportsField MANAGEMENT
Cultivation and Surface Management BMPs


HOW?
... can sports field managers interpret and apply published scientific research findings?


https://sportsfieldmanagement.org
Home
About SFMA
The Institute
Job Board
News
Programs
My SFMA
Join Today
Home
My Information
My Transactions
My Committees
My Events
Membership, Merchandise & Online Registration
Searchable Membership Directory
SFMA Apparel
TGIF
Survey Home Page
Contact Us
Go Back to SportsFieldManagement.org


https://tic.msu.edu/tgif/search/guided
Turfgrass Information File (TGIF)
TGIF Search
MICHIGAN STATE

Scientific Research Publications

Components

- Abstract
- Introduction
- Materials and Methods
- Results and Discussion
- Conclusion

Scientific Research Publications

Components

- **ABSTRACT**
  - Research summarization

Scientific Research Publications

Components
- Abstract
- **INTRODUCTION**
  - Background information
  - Hypotheses
  - Research objectives


Does variability within natural turfgrass sports fields influence ground-derived injuries?

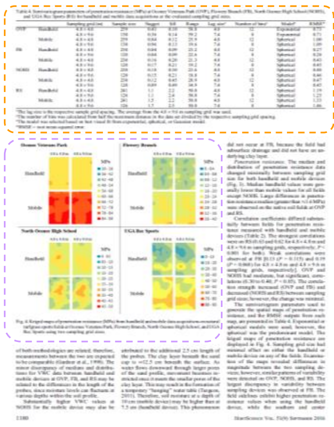
Scientific Research Publications

Components
- Abstract
- Introduction
- **MATERIALS AND METHODS**
  - Experimental area
  - Treatment applications
  - Imperial vs metric units
  - Data collection & analyses

Scientific Research Publications

<u>Components</u>

- Abstract
- Introduction
- Materials and Methods
- **RESULTS AND DISCUSSION**
  - Environmental conditions
  - ANOVA table
  - Tables
  - Figures



Analysis of Variance (ANOVA)

Table 1. Analysis of variance of green turf coverage during 2015 and 2016.

Source of Variation	2015	2016
	—— Prob F ——	
Cultivar	< 0.0001	< 0.0001
Irrigation	< 0.0001	< 0.0001
Cultivar × irrigation	ns	ns
Month	< 0.0001	< 0.0001
Cultivar × month	< 0.0001	< 0.0001
Irrigation × month	< 0.0001	< 0.0001
Cultivar × irrigation × month	0.0005	0.0002

<u>Statistical Significance</u>

- **≤** 0.05 = significant
- **>** 0.05 = nonsignificant

"*... we are **95% confident** that these findings are a result of the treatment(s) and **<u>not</u> due to random chance***"

Analysis of Variance (ANOVA)

Table 1. Repeated measures ANOVA for collection criteria showing significance among soil water content (SWC) and traffic events (T) during fall 2014 and 2015 in Knoxville, TN, on a hybrid bermudagrass [*Cynodon dactylon* (L.) Pers. × *C. transvaalensis* Burtt Davy, 'Tifway'] athletic field on two separate root zones (silt loam and sand root zone).

Effect	df	DIA cover†	Surface hardness‡	Bulk density§	Porosity§ Air	Porosity§ Water	Organic matter§	Clipping yield	Shear strength¶
					Silt loam soil				
Replication	3	NS#	NS	NS	NS	NS	NS	NS	NS
SWC	3	***	***	***	NS	NS	NS	NS	***
T	49	***	***	***	*	NS	NS	*	***
SWC × T	147	***	***	NS	NS	NS	NS	NS	***
					US Golf Association sand root zone				
Rep	3	NS	NS	NS	NS	NS	NS	NS	NS
SWC	3	***	***	***	NS	NS	NS	NS	NS
T	49	***	***	***	**	NS	NS	***	***
SWC × T	147	***	***	NS	NS	NS	NS	NS	NS

* Significant at the 0.05 probability level.

** Significant at the 0.01 probability level.

*** Significant at the 0.001 probability level.

\# NS, not significant at $\alpha \leq 0.05$.

https://doi.org/10.2135/cropsci2017.10.0645

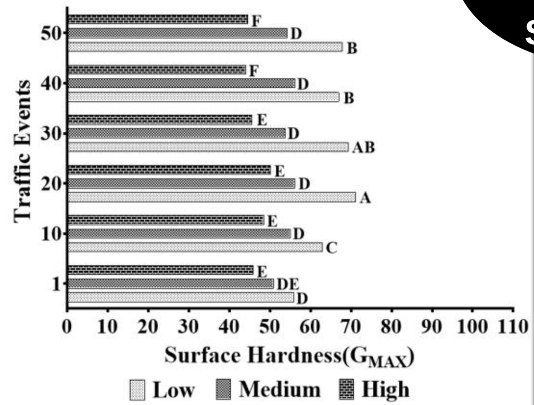
Means Separation

Table 2. Mean monthly green turf coverage on Kentucky bluegrass cultivars under deficit irrigation in 2015.

Cultivar	Irrigation†	June‡	July	Aug.	Sept.
		Green turf coverage (%)			
Mallard	100	92.8 a§	80.9 a	68.4 a	76.3 a
Mallard	80	92.3 a	75.9 b	60.3 a	64.5 b
Mallard	60	90.3 a	66.0 b	50.1 b	54.2 c
Mallard	50	91.2 a	65.9 b	41.2 c	43.6 d
Mallard	40	88.1 a	50.1 c	27.5 d	27.9 ef
Snap	100	77.3 b	34.4 d	40.3 c	56.2 bc
Snap	80	76.6 b	31.6 de	28.6 d	35.3 de
Snap	60	78.6 b	28.7 de	16.8 e	20.5 fg
Snap	50	77.7 b	23.3 e	12.1 ef	17.5 g
Snap	40	65.6 c	14.1 f	6.0 f	8.4 h

§ Within columns, means followed by the same letter are not significantly different according to Fisher's protected LSD (0.05).

Means Separation



https://doi.org/10.2135/cropsci2017.10.0645

Fig. 2. Surface hardness (G_{MAX}) changes in response to soil water contents across traffic events applied to hybrid bermudagrass [*Cynodon dactylon* (L.) Pers. × *C. transvaalensis* Burtt Davy, 'Tifway'] established on (a) silt loam soil and (b) sand meeting US Golf Association specification root zone. Fifty traffic events were applied over 10 wk (5 per week) across (a) four soil water contents (low = 0.6–0.13 $m^3\ m^{-3}$, medium = 0.14–0.21 $m^3\ m^{-3}$, medium-high = 0.22–0.29 $m^3\ m^{-3}$, and high = 0.30–0.37 $m^3\ m^{-3}$) and (b) three water contents (low = 0.05–0.11 $m^3\ m^{-3}$, medium = 0.12–0.19 $m^3\ m^{-3}$, and high = 0.20–0.27 $m^3\ m^{-3}$) during fall 2014 and 2015 in Knoxville, TN. Letters that are similar are not significantly different at α = 0.05 according to Fisher's LSD.

Least Significant Difference

GENETIC COLOR RATINGS OF BENTGRASS CULTIVARS 1/
GROWN ON A GREEN
2015-19 DATA

GENETIC COLOR RATINGS 1-9; 9=DARK GREEN 2/

NAME	AR1	GA3	IA1	IN1	KS1	MI1	MN1	NC1	NJ1	OK1	UT1	VA1	MEAN
NIGHTLIFE	8.7	7.7	8.4	8.7	8.3	7.7	8.7	8.5	6.4	6.3	8.4	8.5	8.1
ARMOR	8.7	7.7	8.1	8.7	8.3	7.7	8.3	8.4	6.0	6.3	8.0	8.0	7.9
KINGDOM	8.3	7.4	8.3	8.5	7.3	7.7	8.5	8.4	6.3	6.8	8.3	8.3	7.9
777 (DLFPS-AP/3054)	8.0	7.4	7.3	6.9	7.1	6.3	6.1	6.9	6.6	5.8	6.3	7.0	6.7
PIRANHA (DC-1)	7.0	7.3	7.6	6.9	7.3	6.3	5.8	7.1	6.6	5.9	6.1	6.5	6.7
DLFPS-AP/3056	7.7	7.2	7.3	7.0	6.9	6.5	6.5	7.1	6.0	4.5	6.3	7.0	6.7
LUMINARY	7.3	7.2	6.9	6.7	6.9	6.3	6.3	6.9	6.7	5.8	5.8	6.7	6.6
MACDONALD (DLFPS-AP/3018)	7.3	7.1	7.1	7.0	7.1	6.3	5.6	6.9	6.3	6.0	5.8	6.3	6.6
V-8	8.0	7.1	7.1	7.7	7.0	6.4	5.5	7.0	4.9	6.0	6.3	6.3	6.5
PURE ECLIPSE (PST-ROPS)	8.0	7.3	7.4	7.3	7.1	6.3	5.2	6.9	5.3	4.4	6.3	6.3	6.5
PENN A-1	8.0	7.1	6.5	7.1	7.0	6.4	6.3	7.1	4.5	5.7	6.3	6.5	6.5
DLFPS-AP/3058	7.7	7.3	7.4	6.5	7.1	6.3	4.7	6.9	5.9	5.7	5.9	6.5	6.4
PURE SELECT	7.0	7.0	7.1	7.5	7.0	6.3	5.5	6.8	5.0	5.3	5.8	6.0	6.4
TOUR PRO (GDE)	8.0	7.3	7.0	6.7	7.0	6.3	4.9	6.9	5.9	5.3	5.9	6.5	6.4
SHARK	8.0	7.1	6.7	7.1	6.9	6.3	4.9	6.7	5.5	5.8	5.8	6.5	6.3
L-93 XD	8.0	7.0	7.0	6.3	6.8	6.2	4.6	6.9	7.0	4.5	5.6	6.5	6.3
BARRACUDA	8.0	6.8	6.7	7.0	6.9	6.3	5.3	6.8	4.8	5.8	5.3	6.3	6.2
DLFPS-AP/3059	7.3	6.8	6.8	6.6	7.7	6.3	4.9	6.9	4.4	5.8	5.8	6.5	6.2
DECLARATION	7.7	6.4	6.8	6.5	7.1	6.0	5.1	7.0	5.9	5.3	4.9	6.5	6.2
PENNCROSS	8.0	6.5	6.1	6.2	7.1	5.7	4.5	6.1	2.3	5.7	3.5	6.7	5.4
LSD VALUE	1.5	0.6	1.3	0.8	0.6	0.4	1.0	0.5	1.5	1.6	1.1	1.0	0.4
C.V. (%)	12.1	5.2	11.5	7.4	5.5	3.8	10.8	4.8	16.6	18.3	11.7	9.3	9.8

1/ TO DETERMINE STATISTICAL DIFFERENCES AMONG ENTRIES, SUBTRACT ONE ENTRY'S MEAN FROM ANOTHER ENTRY'S MEAN. STATISTICAL DIFFERENCES OCCUR WHEN THIS VALUE IS LARGER THAN THE CORRESPONDING LSD VALUE (LSD 0.05).

2/ C.V. (COEFFICIENT OF VARIATION) INDICATES THE PERCENT VARIATION OF THE MEAN IN EACH COLUMN.

Standard Deviation

Table 1. Descriptive statistics of soil moisture (volumetric water content), soil compaction (penetration resistance), turfgrass quality (normalized difference vegetation index), and surface hardness for games 1 and 2.[a]

Surface property[b]	Minimum	Maximum	Range	Mean ± SD	CV (%)
Soil moisture (%)					
Game 1 (*n* = 596)	38.8	65.4	26.6	51.6 ± 4.3	8.3
Game 2 (*n* = 670)	29.9	61.7	31.8	45.0 ± 5.8	11.8
Soil compaction (MPa)					
Game 1 (*n* = 596)	0.9	7.4	6.5	3.3 ± 1.1	33.0
Game 2 (*n* = 670)	1.0	11.8	10.8	4.6 ± 1.5	32.6
Turfgrass quality (NDVI)					
Game 1 (*n* = 483)	0.71	0.96	0.25	0.91 ± 0.04	4.4
Game 2 (*n* = 493)	0.68	0.95	0.27	0.87 ± 0.06	6.9
Surface hardness (Gmax)					
Game 1 (*n* = 54)[c]	29.0	64.0	35.0	38.8 ± 7.3	18.8
Game 2 (*n* = 238)	27.0	76.0	49.0	47.8 ± 10.5	22.0

CV: coefficient of variation; NDVI: normalized difference vegetation index; SD: standard deviation.

https://doi.org/10.1177/1754337119901090

Standard Error

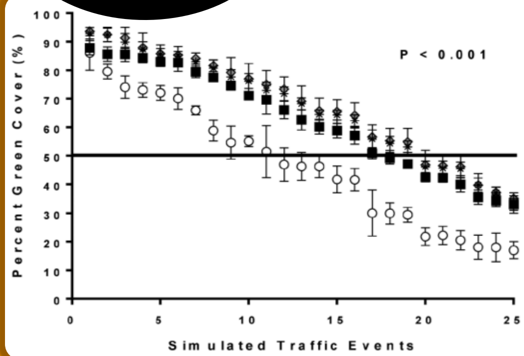
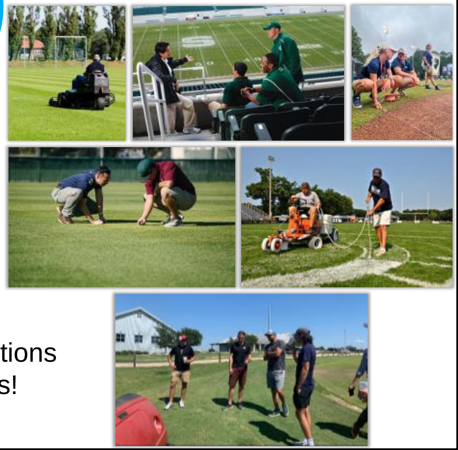


Fig. 1. Changes in hybrid bermudagrass [*C. dactylon* (L.) Pers. × *C. transvaalensis* Burtt Davy 'Tifway'] percentage green turfgrass cover with different crumb rubber topdressing depths after 25 simulated traffic events combined from fall 2011 and 2012 in Knoxville, TN. Standard error bars are presented as a means of statistical comparison. Black lines represent where values drop below 50% green turfgrass cover. Best-fit parameter estimates for linear regression equations modeling responses are presented in Table 2.

https://doi.org/10.2135/cropsci2017.03.0168

Scientific Research Publications



Components
- Abstract
- Introduction
- Materials and Methods
- Results and Discussion
- **CONCLUSION**
  - Implications and applications
  - Connect with the authors!

DATA and DECISIONS

- Don't be afraid to ask **QUESTIONS**
- Use data to **INFORM** decisions
- Apply **SCIENTIFIC** findings
- Conduct your own **RESEARCH**
- **JUSTIFY** your decisions using data

Further Reading

- Baird, J. 2003. How statistics can lie. USGA Green Section Record. May-June. pp: 21-23.
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