

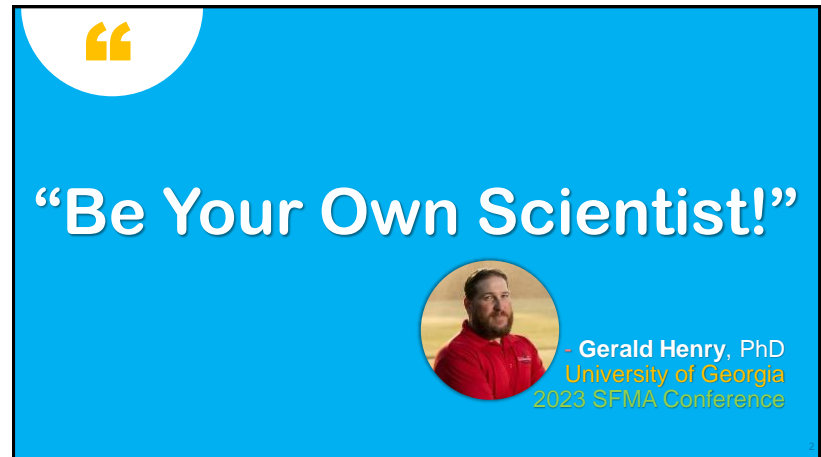


DATA AND DECISIONS


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!

BEST MANAGEMENT PRACTICES FOR THE SPORTS FIELD MANAGER:
A PROFESSIONAL GUIDE FOR ENVIRONMENTAL SPORTS FIELD MANAGEMENT

SPORTS FIELD



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**

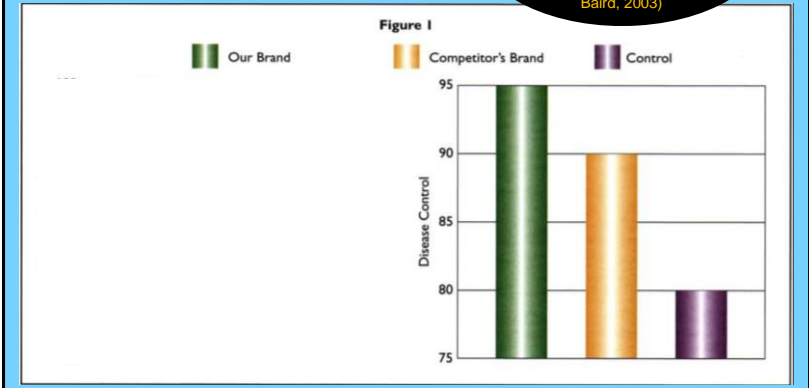
ASK QUESTIONS!

(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**?

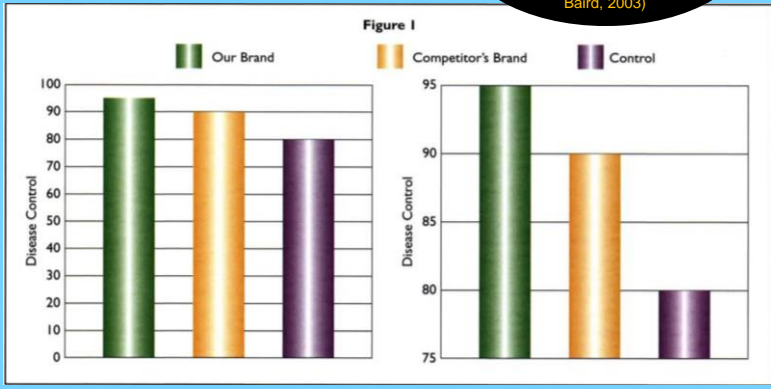
An Axis of Evil

(Bergstrom and West, 2020;
Baird, 2003)



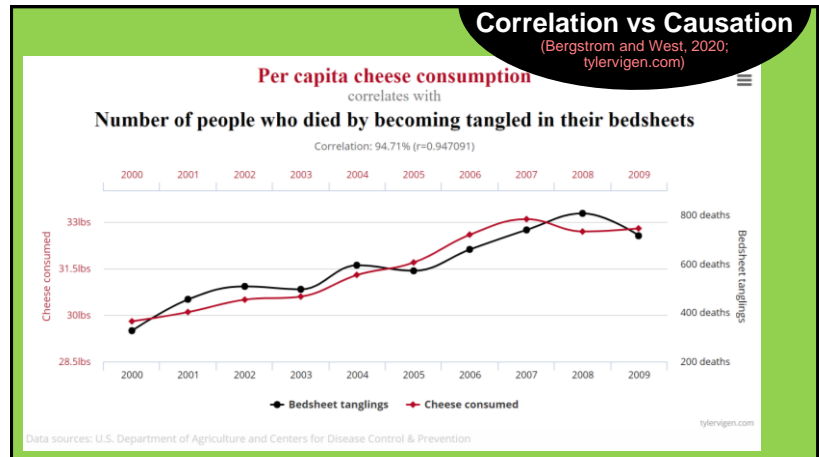
An Axis of Evil

(Bergstrom and West, 2020; Baird, 2003)




Correlation vs Causation


(Bergstrom and West, 2020; tylervigen.com)



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

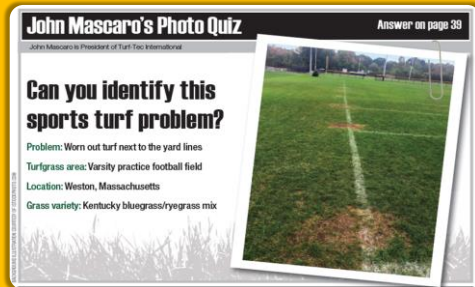
Observation

- You have questions



Observation

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



The Scientific Method

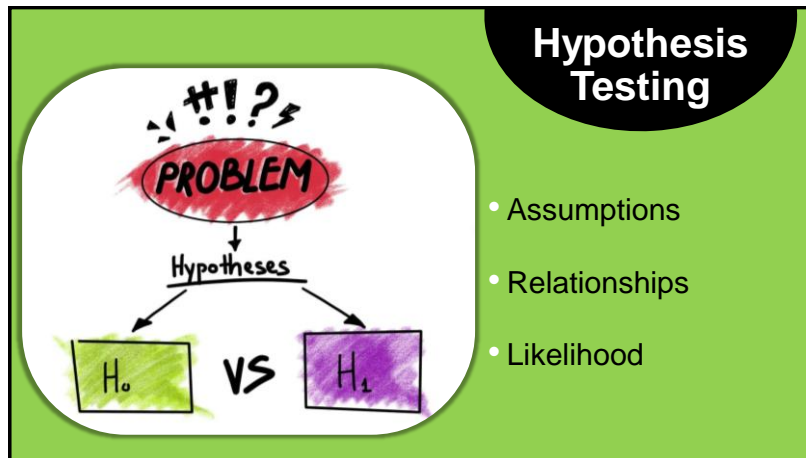
Observation

- You have questions

Hypothesis Testing

- Relationships and impacts





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

How much does turfgrass research cost?

The turfgrass industry has long been a source of pride for many people. It is a source of food, fiber, and recreation. The industry is also a source of research. Turfgrass researchers work to improve the quality of turfgrass and to develop new varieties. This research is essential for the industry's future. However, turfgrass research is expensive. The cost of a single plot can range from \$100 to \$1,000. The total cost of a research project can range from \$10,000 to \$100,000. This cost is often a barrier to entry for many researchers. Funding is often difficult to come by. The role of turfgrass researchers is to improve the quality of turfgrass and to develop new varieties. This research is essential for the industry's future. However, turfgrass research is expensive. The cost of a single plot can range from \$100 to \$1,000. The total cost of a research project can range from \$10,000 to \$100,000. This cost is often a barrier to entry for many researchers. Funding is often difficult to come by.

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**

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

Rep 1 Rep 2 Rep 3 Rep 4

- How many treatments?
- How many replications?

Experimental Design

(Davis et al., 2017)

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

UTC MH 1	TRT C MH 1	TRT A MH 1	TRT B MH 1
TRT B MH 2	UTC MH 2	TRT C MH 2	TRT A MH 2
TRT A MH 2	TRT B MH 2	UTC MH 2	TRT C MH 2
TRT C MH 1	TRT A MH 1	TRT B MH 1	UTC MH 1
UTC MH 1	TRT B MH 1	TRT A MH 1	TRT C MH 1
TRT B MH 2	UTC MH 2	TRT C MH 2	TRT A MH 2

Rep 1

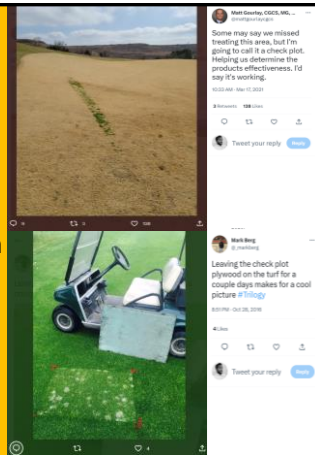
Rep 2

Rep 3

- 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>

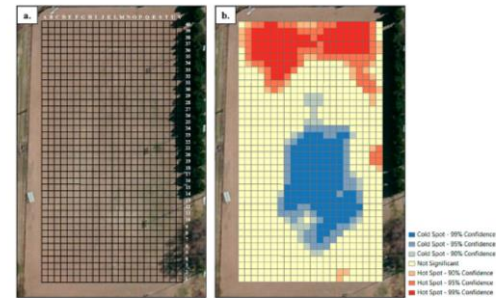


Figure 1. Illustration of (a) the geo-referenced alphanumeric grid (3 m² cells) that was provided to athletes in questionnaires to report where injuries occurred on the field (corresponding letter and number signs lining along a fence in the fields) and (b) a hot spot map (red and blue cells represent 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

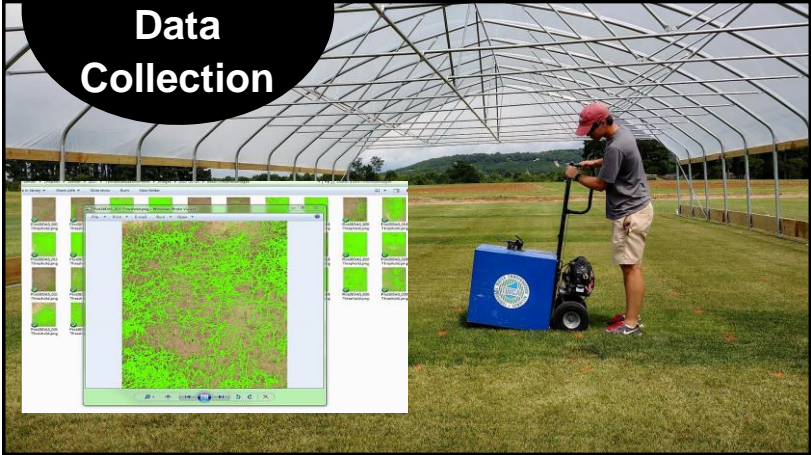
Data Dissemination

- A multitude of mediums



Data Collection





Data Analysis

Collaboration

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

HEALTHY EDUCATION

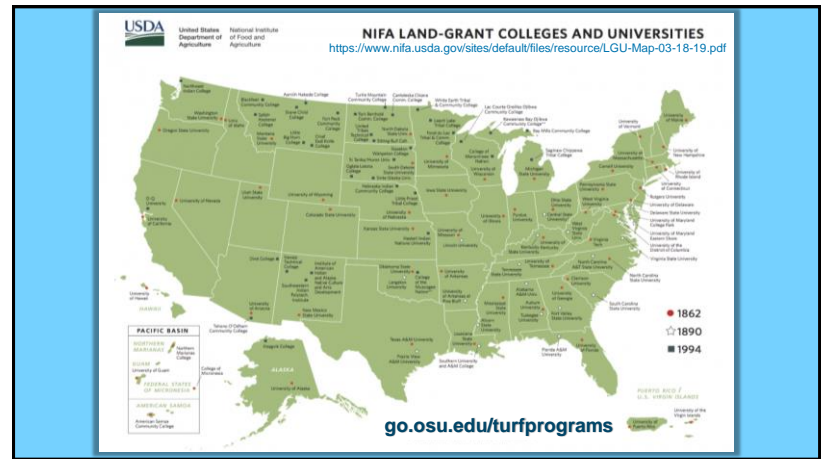
College and University Turfgrass Programs

CONCEPT The knowledge of turfgrass and turfgrass management is a critical component of turfgrass science and practice. Turfgrass science and practice are the foundation of turfgrass management and are the primary focus of turfgrass education programs. Turfgrass science and practice are the foundation of turfgrass management and are the primary focus of turfgrass education programs.

THESE LEAD TO: The knowledge of turfgrass and turfgrass management is a critical component of turfgrass science and practice. Turfgrass science and practice are the foundation of turfgrass management and are the primary focus of turfgrass education programs.




SAFE
The Foundation for Safer Athletic Fields





https://sportsfieldmanagement.org

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Stay Connected

The Sports Field Management Association (SFMA) is your direct connection to the technical information and people resources that you will need to excel! We are dedicated to helping you succeed personally and professionally.

Be sure that you are taking advantage of all that your membership offers. If you are not currently a member, we encourage you to join today and become engaged in the vibrant profession of sports field management.

Join Today

SFMA Advance Your Career

Membership in SFMA is an investment in yourself. SFMA may be the most economical "employment insurance" you can buy. SFMA helps to provide:

Job Security

By taking advantage of programs and resources, you proactively enhance your value to your employer.

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The knowledge, skills and abilities you gain by accessing SFMA's education and information can help you to prepare to take that next step in your career.

Recognition of your Professionalism.

In addition to the individual recognition you receive because of the

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Monthly SportsField Management Magazine and Online Newsletter

Educational Resources - Bulletins, Booklets, DVDs, Online classes

Use of the PC to validate your work Certification Programs

Awards Program, Scholarships & Grants

Annual Conference & Exhibition

Employment and Career Resources

SFMA Industry Sourcebook

Chapter Resources

Membership Directory - real-time, online

https://tic.msu.edu/tgif/search/guided

Turfgrass Information File (TGIF)

USGA

About TGIF Search TGIF Search Help Turfgrass Information Center (TIC) The TIC Environment Feedback

1 Fall 2022 Update:

During the Fall 2022 semester, there are several issues to get in touch with the Turfgrass Information Center:

- The department will no longer be open to the public Tuesday, Wednesday and Thursday, from 9am.
- For general inquiries or to schedule a meeting with a TIC Librarian, visit [tgif@msu.edu](#).
- In the Turfgrass Information Center metadata, please make an appointment in the calendar: Special Collections Reading Room, 400B Old Main Building.
- If you are looking for TGIF Database access, use our SPDRS/TGIF login to get in today; no membership, no fee! - we remain committed to help those working and learning remotely.

TGIF Search

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All kinds of items:

Limit to: Turfgrass Publications Plant-Net Content Exclude abstract-only records Exclude blog records

Display Format: (Default) - Brief Table

Results Per Page: 25

Display Alignment

MICHIGAN STATE UNIVERSITY

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Scientific Research Publications

Components

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

The screenshot shows a journal page with several articles. The main article is titled "Does variability within natural turfgrass sports fields influence ground-derived injuries?" by Christi M. Strawn, Christine O. Sandison, Gerald M. Henry, and Catelyn N. Brown. Other visible titles include "Long-term Effect of Open-Spoon Aeration on Plant and Soil Properties of Community Level Sports Fields", "Comparison of blackwater infiltration and conventional fertilization methods on athletic fields", "Impact of Soil Water Content on Hybrid Bermudagrass Athletic Fields", "Handheld versus Mobile Data Acquisition for Spatial Analysis of Natural Turfgrass Sports Fields", and "Soil Infiltration on an Athletic Field Infield versus".

Scientific Research Publications

Components

- **ABSTRACT**
- Research summarization

The screenshot shows the abstract of the article "Does variability within natural turfgrass sports fields influence ground-derived injuries?". The authors are Christi M. Strawn, Christine O. Sandison, Gerald M. Henry, and Catelyn N. Brown. The abstract text reads: "Natural turfgrass sports fields exhibit within-field variations due to climatic conditions, field construction, field management, and live traffic patterns from field usage. Variance within a field could influence the playing surface, availability and major attributes to many aspects of player performance that lead to increased ground-derived injury occurrence. This study conducted a non-destructive aerial analysis to compare the physical consistency between artificial and natural turfgrass sports field properties and ground-derived injuries. Consistent field characteristics were compared to ground-derived injuries over one year. Soil moisture, turfgrass quality, surface hardness, and turfgrass slope strength were measured from four test fields. The topographic variability was significantly higher for artificial and live turfgrass sports fields. Injury incidence was compared to live turfgrass field strength. Statistical significance was determined if there were differences between artificial and natural turfgrass fields. Results demonstrated that ground-derived injuries were reported overall. The majority of injury occurrences occurred in turfgrass quality and slope (12.19% CI 0.24-0.76) and soil moisture (10.3% CI 0.24-0.46) was significantly higher than reported (22.0% CI 0.46-0.82 and 22.7% CI 0.46-0.82, respectively). Slope changes in specific areas of turfgrass quality, soil moisture, and surface hardness were among the top risk factors. These results suggest potential relationships between within-field variations and ground-derived injuries, particularly in consistent areas between management and adjacent high and low values. Future longitudinal studies are necessary to investigate the potential relationships to reduce the understanding and injurious outcomes that reduce ground-derived injuries." The abstract concludes with keywords: "artificial turfgrass sports field properties, turfgrass quality, soil moisture, surface hardness".

Scientific Research Publications

Components

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



Scientific Research Publications

Components

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



Figure 1. Illustration of the Precision Farming and the sampling of nutrient (nitrogen, water content, and nitrogen quality) over natural differences in vegetation cover, soil and ground-derived data. 1) A CropSense sensor mounted on the tractor, and 2) the 1000 Series Design Team and 3) the sampling nitrogen sensor.

Soil moisture was measured with the PDS1000 (range: 0–4.4 × 2.5 m sampling grid, 1–1000 2000 samples depending on field). For the nitrogen treatment, the field, every field measurement was flagged for hand-field data collection (operator, surface, surface and nitrogen flux amount) were measured using a 4.0 × 1.0 m sampling grid (0.205 100 samples depending on field). Surface hardness and nitrogen flux amount were also measured periodically for one experimental area during the entire of the study. Since the NDVI sensor on the PDS1000

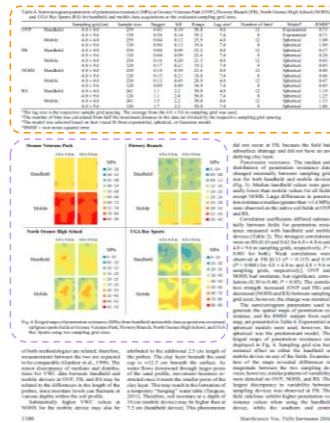
measured data in a representative rate, nitrogen quality data were manipulated to correspond with the hand-field sampling system. A National Instruments (NI) GPS (Nimble), Inc., Alberta, Canada, with software real-time wireless map data attached to the PDS1000 to geo-reference all data.

Data analysis
This open stage to identify within-field variability of each field progress were created in ArcGIS to map.

Scientific Research Publications

Components

- 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	< 0.0001	< 0.0001
Irrigation	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Cultivar × irrigation	ns	ns	ns	ns
Month	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Cultivar × month	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Irrigation × month	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Cultivar × irrigation × month	0.0005	0.0002		

Statistical Significance

- ≤ 0.05 = significant
- > 0.05 = nonsignificant

“... we are **95% confident** that these findings are a result of the treatment(s) and **not 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* Burt Davy, 'Tifway'] athletic field on two separate root zones (silt loam and sand root zone).

Effect	df	DIA cover†	Surface hardness‡	Bulk density§	Porosity§		Organic matter§	Clipping yield	Shear strength¶
					Air	Water			
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/croplsc2017.10.0645>

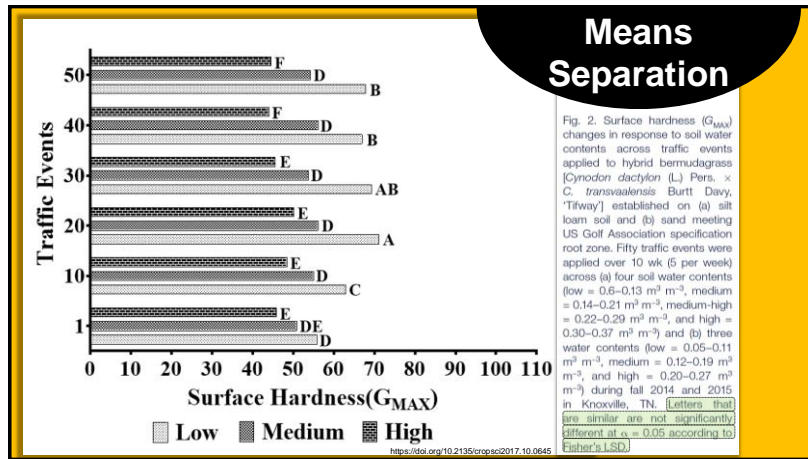
Means Separation

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

Cultivar	Irrigation†	Green turf coverage (%)			
		June‡	July	Aug.	Sept.
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).





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	ARI	GAS	IA1	IN1	KS1	MI1	HI1	NC1	NI1	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
ARJOR	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
PERANNA (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
PENH 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 (ODE)	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	4.6	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

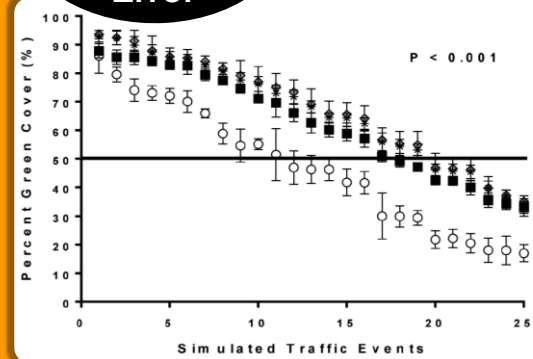


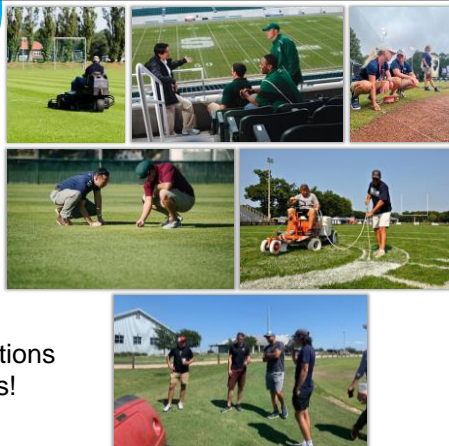
Fig. 1. Changes in hybrid bermudagrass [*C. dactylon* (L.) Pers. × *C. transvaalensis* Burt Davy 'Tifway'] percentage green turfgrass cover with different crumb rubber topdressing depths after 25 simulated traffic events combined from fall 2011 and 2012 in Knoxville, TN. Standard error bars are presented 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/croplsc2017.03.0168>

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.
- Bergstrom, C. and J. West. 2020. Calling bullshit. Random House Publishing Group.
- Carrow, R.N. 2000. Purchasing new products and technologies: an ethical and common-sense approach. USGA Green Section Record. May/June pp: 17-20.
- Davis, R.F., G.H. Harris, P.M. Roberts, and G.E. MacDonald. 2017. Designing research and demonstration tests for farmers' fields. UGA Extension. Bulletin 1177. extension.uga.edu
- Follis C. and B. Fresenburg. 2014. What did that professor say? Statistics made easy. SportsTurf. April. pp: 8-10, 44-45.
- Pace Turf. 2010. Testing products and practices: a guide for golf course superintendents. August. www.paceturf.org
- Watkins, E. 2020. How much does turfgrass research cost? Golf Course Management. March. pp: 30.

DATA AND DECISIONS

Applying Research in Sports Field Management Practices

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