

# Off-Type Management in Ultradwarf Bermudagrass Putting Greens

**E.H. Reasor, Ph.D.**

 **@TurfBlade**



*There are known knowns; there are things we know that we know.*

*There are known unknowns; that is to say, there are things that we now know we don't know.*

*But there are also unknown unknowns – there are things we do not know we don't know.*

-Donald Rumsfeld

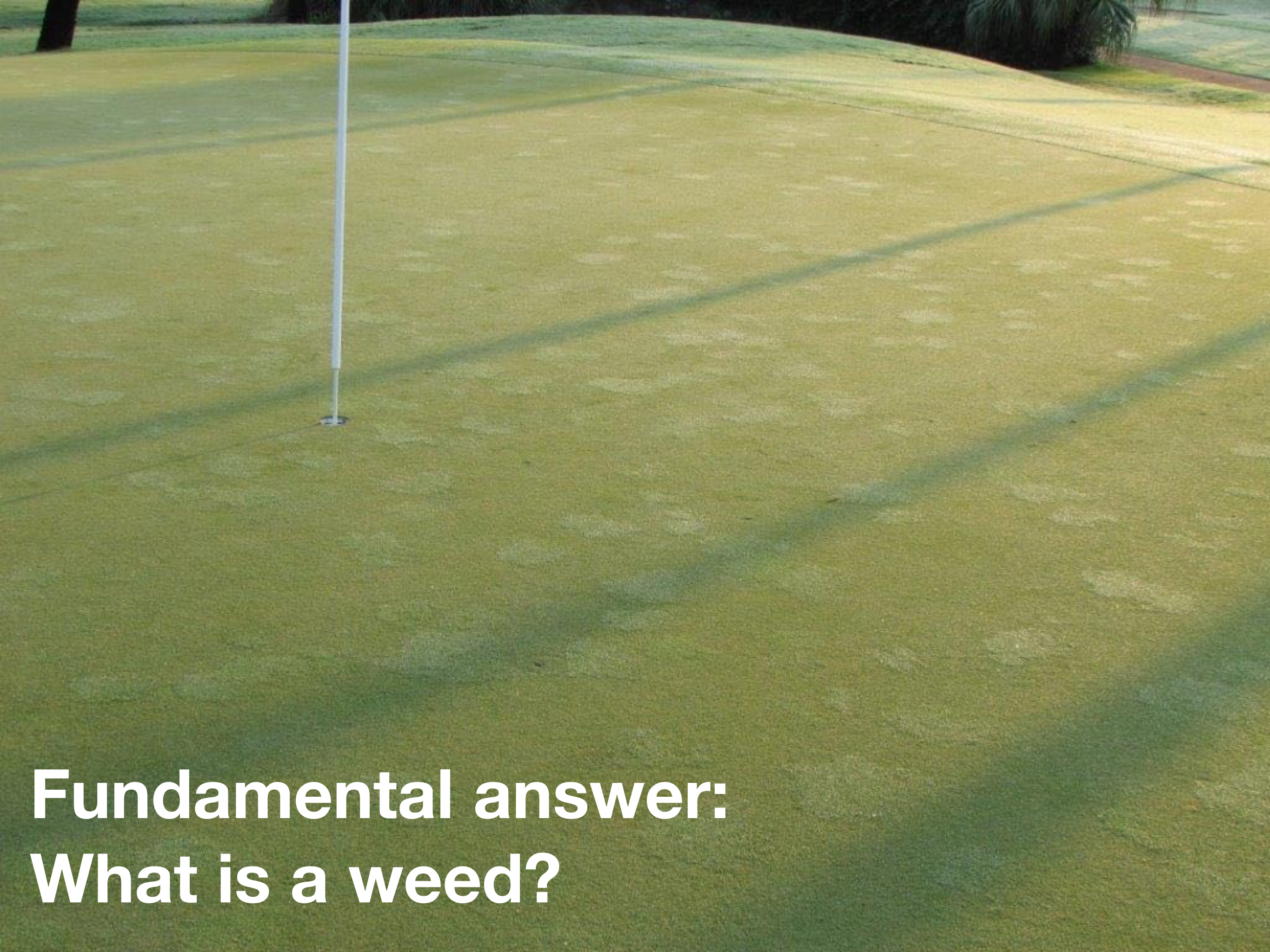






**Many are reporting trouble  
with off-types**





**Fundamental answer:  
What is a weed?**















**Grasses with  
different  
MORPHOLOGY  
and  
PERFORMANCE  
than desired turf**





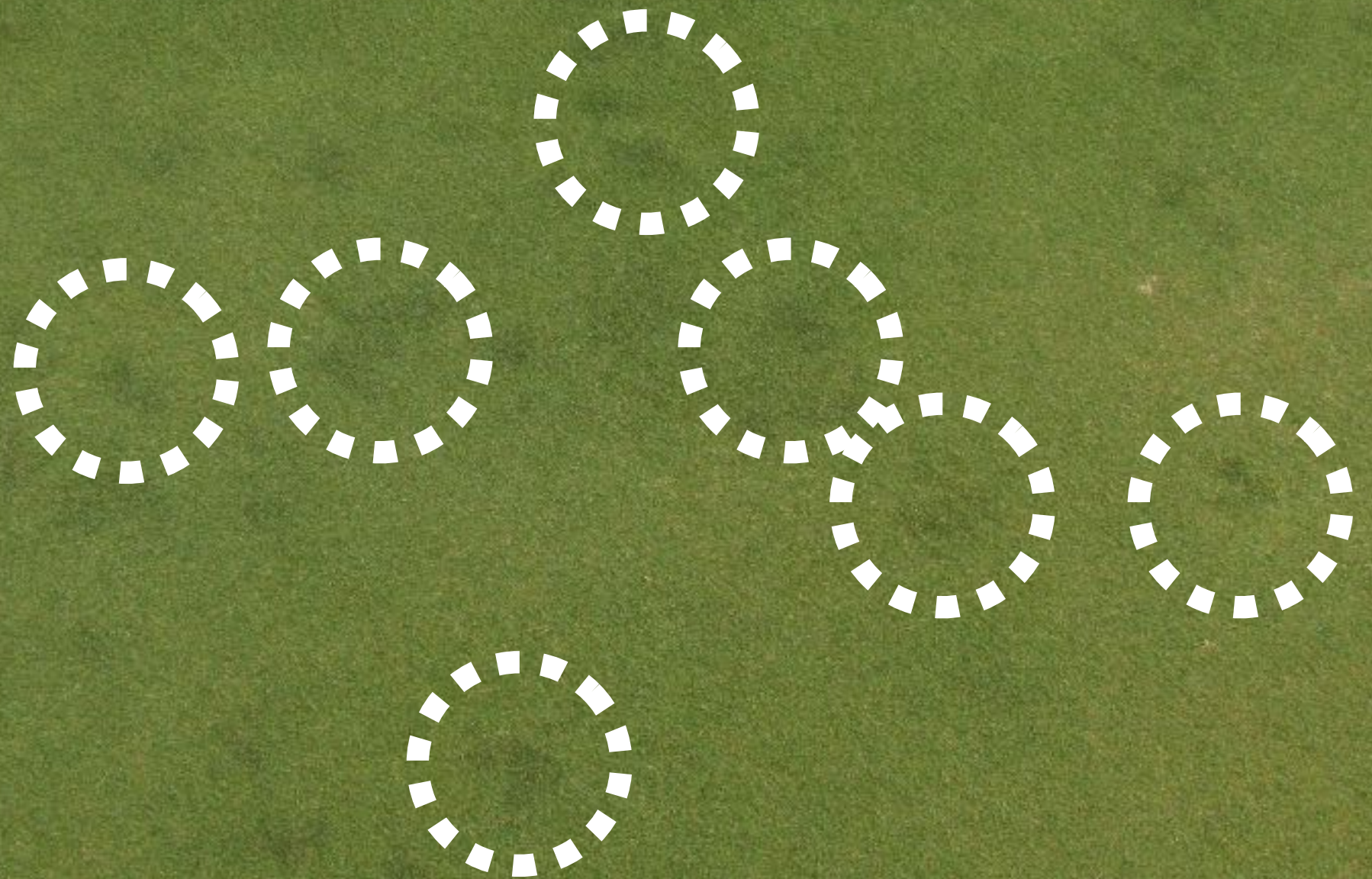






Lighter color





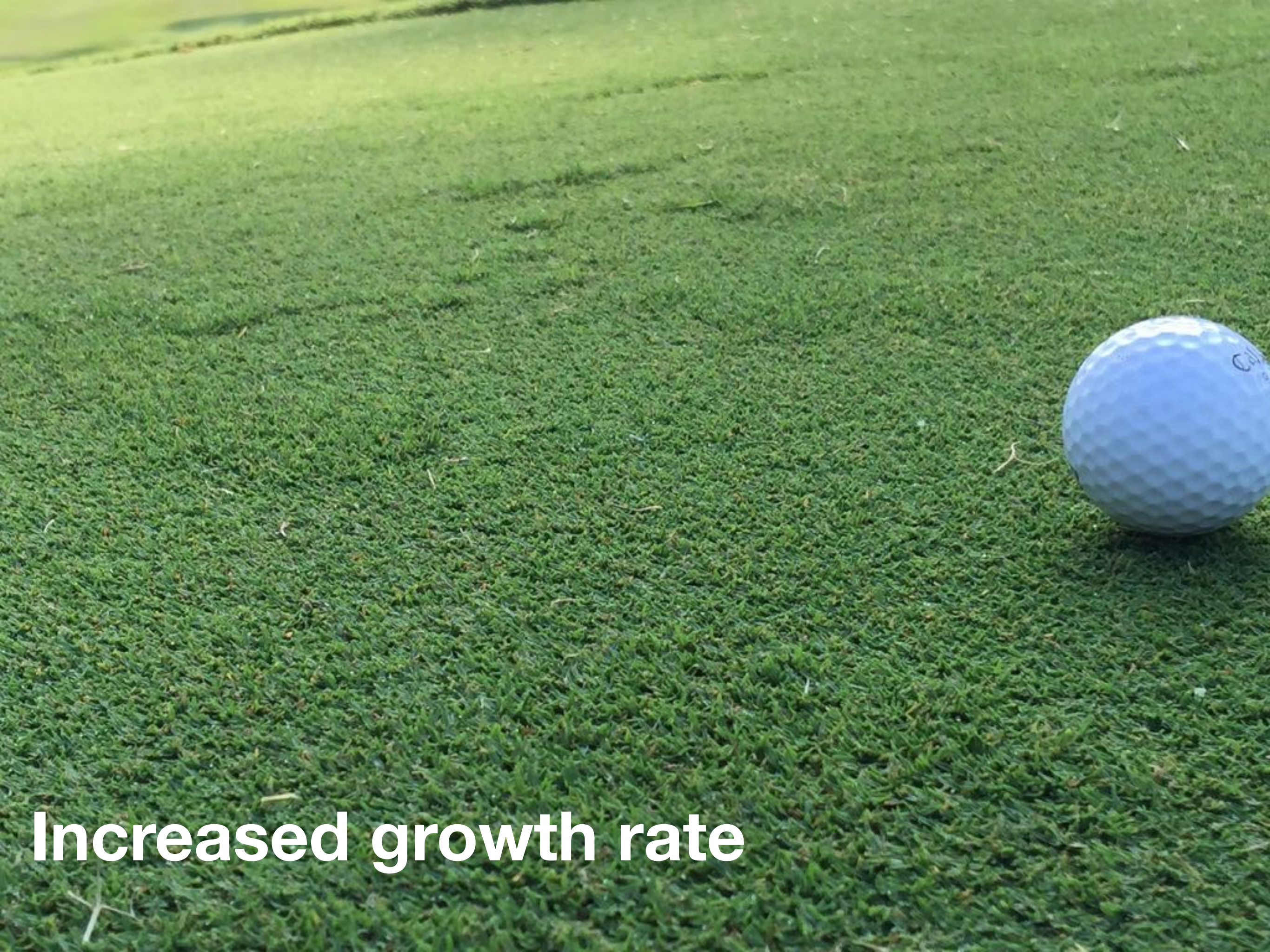
**Darker color**





**Distinct patch appearance**





**Increased growth rate**









**Aesthetic issues**





**Scalping**





**Patch  $\neq$  Off-type**



# *Gaeumannomyces graminis* (GG)

## Take-all patch













# Bermudagrass Decline

- Tend to be an issue on newer, sandier greens
- Associated with micronutrient deficiencies (Mn, etc)
  - High pH soil/water, high in sodium, bicarbonate
  - *Addressing the small details*
- Nematodes can cause lesions for pathogen to infect
- Symptoms can be masked in summer, more visible in shoulder seasons



# If you see this...

- Consult your local pathologist
- Test pH of soil/water, as well as nutrients
- Acidifying nitrogen sources
- Adjust micronutrients to balance availability issues
- Critical need for fungicide programs in shoulder seasons
- Re-evaluate your PGR program







# **Optimize Programs for Other Pests**



# What Type of Testing?

- Soil nutrient analyses
- Irrigation water testing
- Disease diagnostics
- Nematode assays

***Ruling out other factors help confirm off-type issues***







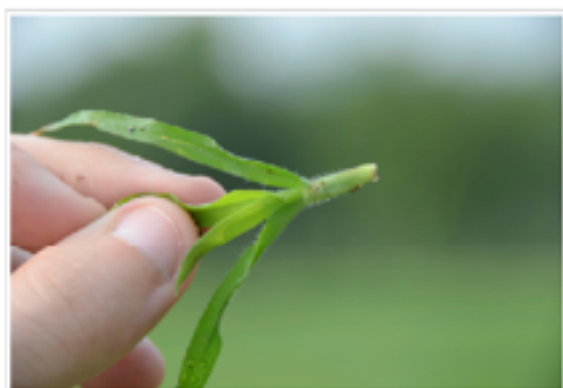
# Weed Diagnostics Center

Weed Diagnostics Center

Diagnostic Services

Sample Submission

Contact



Weed Identification



## University of Tennessee Weed Diagnostics Center

The University of Tennessee Weed Diagnostics Center (UTWDC) provides diagnostic testing of weeds infesting both crop and non-cropland systems including maintained turfgrass, ornamentals, and utility rights of way. The UTWDC blends both whole plant and molecular techniques to provide customers with services such as weed identification, herbicide resistance screening, as well as bermudagrass off-type assessment. Results of all diagnostic tests conducted at the UTWDC will be coupled with research-based solutions for managing weeds in the field.

### Why Have Weeds Tested ?

- Proper identification is critical to successful weed control
- Diagnostic results allow managers to implement optimal management strategies
- Results allow managers to conserve labor, financial, and technological resources
- Resistance screening helps steward effective technologies for weed management

# Off-Type Characterization at UT



# Don't be afraid to assess morphology



**Off-Type**

**Desirable**



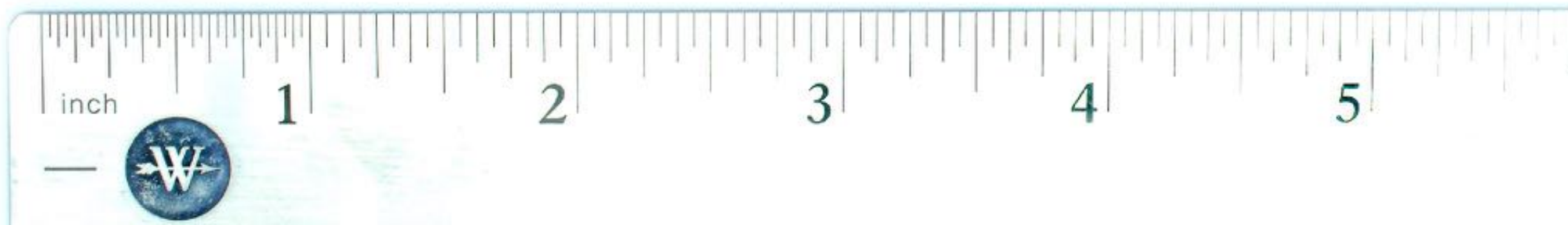
**Minimum 10 stolons with 4 nodes**



**Desirable**



**Off-Type**







Bermudagrass  
Off-type  
Assessment



WEED DIAGNOSTICS CENTER  
**UTIA** INSTITUTE OF  
AGRICULTURE  
THE UNIVERSITY OF TENNESSEE



# Introduction

## XXXXX COUNTRY CLUB (ANYTOWN, USA)

Two ultradwarf bermudagrass samples from XXXX Country Club (Anytown, USA) were submitted to the University of Tennessee Weed Diagnostics Center (WDC) for off-type assessment. Samples were harvested directly from putting surfaces using a standard cup cutter and received by WDC personnel on July 28th, 2016. Upon receipt, samples were transplanted into greenhouse pots filled with peat-based growing media and maintained under controlled conditions optimized for ultradwarf bermudagrass growth. Samples were not mowed after receipt but did receive 0.5 lb nitrogen (N) per 1000 ft<sup>2</sup> per week from a complete fertilizer (20-20-20) and were treated with insecticide as needed.

## BERMUDAGRASS OFF-TYPE ASSESSMENT

Submitted samples were allowed to grow until producing a minimum of at least ten stolons with four nodes. Once this benchmark was reached, diagnosticians at the WDC assessed morphology of both samples by measuring internode length, stolon diameter, leaf length, and leaf width with digital calipers. Measurements were made at the third visible node from the bud and replicated ten times using ten different stolons. All samples were photographed after measurement.



**GRASS A**



Figure 1. Two grasses (Grass A & Grass B) were submitted from XXXX Country Club for off-type assessment. Grasses were cultured to produce a minimum of ten stolons with at least four nodes prior to being morphologically characterized on September 15th, 2016. Image taken after morphological data were collected.

**GRASS B**





Figure 2. Visual differences in leaf length among two grasses (Grass A & Grass B) submitted from **XXXX Country Club** for off-type assessment. Measurements were made September 15th, 2016 using digital calipers

Table 1. Differences in morphological parameters of two grasses (Grass A & Grass B) submitted from **XXXX Country Club** for off-type assessment. Measurements were made September 15th, 2016 using digital calipers and replicated ten times

	GRASS A	GRASS B	Significantly Different <sup>*</sup>
Internode Length (mm)	28.66	30.66	NO
Stolon Diameter (mm)	0.78	0.75	NO
<b>Leaf Length (mm)</b>	<b>9.41</b>	<b>18.34</b>	<b>YES</b>
Leaf Width (mm)	2.10	1.89	NO

<sup>\*</sup>Differences between Grass A and Grass B statistically compared using a Welch Two-Sample T-Test in R-Studio at  $\alpha = 0.05$



**GRASS B****GRASS A**

Figure 2. Visual differences in leaf length among two grasses (Grass A & Grass B) submitted from **XXXX Country Club** for off-type assessment. Measurements were made September 15th, 2016 using digital calipers

Table 1. Differences in morphological parameters of two grasses (Grass A & Grass B) submitted from **XXXX Country Club** for off-type assessment. Measurements were made September 15th, 2016 using digital calipers and replicated ten times

	GRASS A	GRASS B	Significantly Different <sup>*</sup>
Internode Length (mm)	28.66	30.66	NO
Stolon Diameter (mm)	0.78	0.75	NO
<b>Leaf Length (mm)</b>	<b>9.41</b>	<b>18.34</b>	<b>YES</b>
Leaf Width (mm)	2.10	1.89	NO

<sup>\*</sup>Differences between Grass A and Grass B statistically compared using a Welch Two-Sample T-Test in R-Studio at  $\alpha = 0.05$

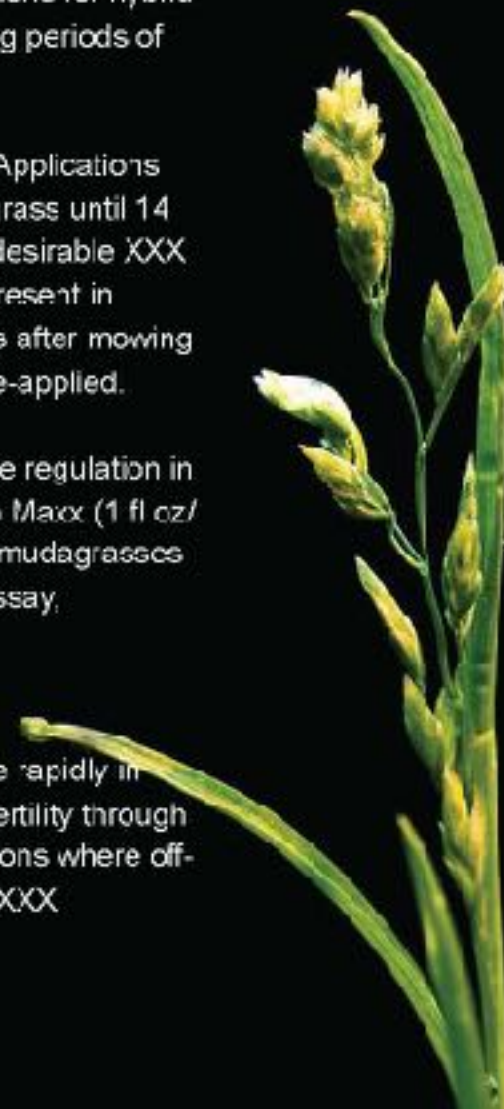


## RESULTS

Grasses submitted for off-type assessment significantly differed in leaf length (Figure 2, Table 1), with Grass A having leaves nearly 50% shorter than Grass B. This variability in morphology suggests that off-type grasses are likely present in putting surfaces at XXXX Country Club. However, the origin of these off-types cannot be determined from this diagnostic assay.

## RECOMENDATIONS

- On-going research at the University of Tennessee is exploring optimal strategies maintaining ultradwarf putting surfaces containing off-types. Changes to plant growth regulator and nitrogen fertility programs can help mask differences in morphology among grasses. To that end, the following management changes should be considered at XXXX Country Club:
  - Do not apply more than 3 fl oz/A of the plant growth regulator trinexapac-ethyl (Primo Maxx) at any time. Applications at the 3 fl oz/A rate (the maximum labeled use rate for ultradwarf putting greens) should only be used during optimal environmental conditions for hybrid bermudagrass growth. Lower rates should be used during periods of sub-optimal weather.
  - Do not apply plant growth regulators on a weekly basis. Applications do not reach peak growth regulation on XXXX bermudagrass until 14 DAT. Applying on shorter intervals will over regulate the desirable XXX bermudagrass creating an advantage for any off-types present in putting surfaces. Measuring the volume of fresh clippings after mowing can determine when plant growth regulators should be re-applied.
  - Prohexadione-Ca (Anuew) has shown efficacy for off-type regulation in preliminary trials. Applications of Anuew (6 oz/A) + Primo Maxx (1 fl oz/A) have been shown to reduce leaf length of off-type bermudagrasses in putting greens. Given the morphology results of this assay, incorporation of Anuew would be recommended at XXXX Country Club.
  - Increases in clipping yield due to nitrogen (N) occur more rapidly in XXX than off-types. Therefore, maintaining balanced N fertility through weekly spoon-feeding is recommended to prevent situations where off-type grasses are at a higher N status than the desirable XXX bermudagrass.





# **Question #1**

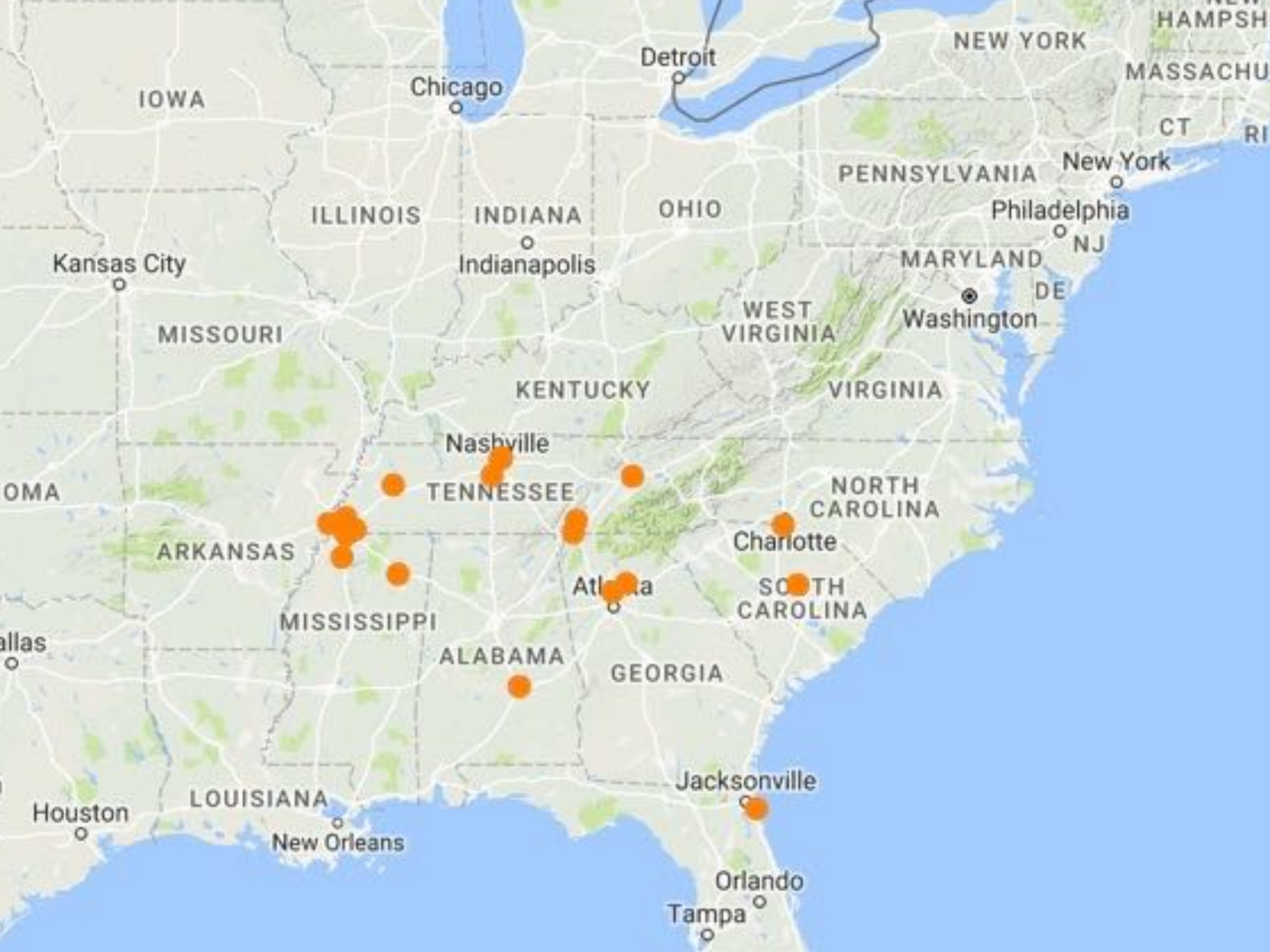
**What are these off-types?**



# Building a Collection

- **Sampled golf courses from 2013-2016**
- **Not a random sample → targeted those with OT issues**
- **Greens established to Champion, MiniVerde, TifEagle, and Sunday**
- **Collected the OT and sample of desirable from each facility**











**After sampling...**  
**What have we learned?**



# Morphological Measurements

(Roche and Loch, 2005)











**Cluster 1**



**Cluster 2**



**Cluster 3**



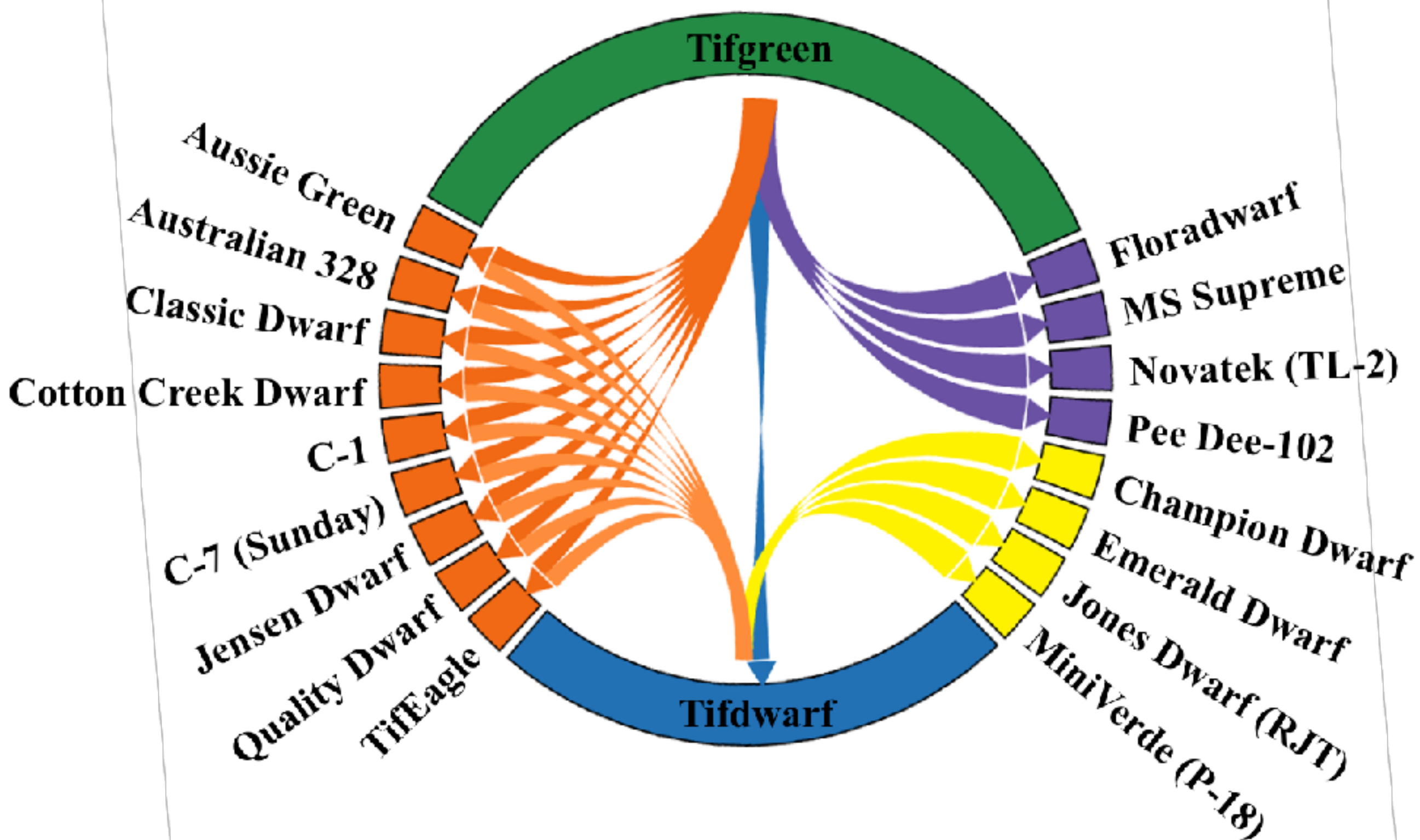
# Flow Cytometry Results

- Measures DNA content in cells
- All 52 samples are triploid hybrids
- Peaks suggest all 52 samples belong to 'Tifgreen' family

Work done in cooperation with Dr. Brian Schwartz










REVIEW

# The genetic and phenotypic variability of interspecific hybrid bermudagrasses (*Cynodon dactylon* (L.) Pers. × *C. transvaalensis* Burtt-Davy) used on golf course putting greens

Eric H. Reasor<sup>1</sup>  · James T. Brosnan<sup>1</sup> · Robert N. Trigiano<sup>2</sup> · J. Earl Elsner<sup>3</sup> · Gerald M. Henry<sup>4</sup> · Brian M. Schwartz<sup>5</sup>

Received: 1 March 2016 / Accepted: 16 July 2016 / Published online: 22 July 2016  
© The Author(s) 2016. This article is published with open access at Springerlink.com

## Abstract

**Main conclusion** Some interspecific hybrid bermudagrass cultivars used on golf course putting greens are genetically unstable, which has caused phenotypically different off-type grasses to occur in production nurseries and putting surfaces. Management practices to

green use in lieu of common bermudagrass. However, off-type grasses began appearing in established Tifgreen stands soon after commercial release. Off-type grasses are those with different morphology and performance when compared to the surrounding, desirable cultivar. Off-types have the potential to decrease surface uniformity, which negatively



**Samples tested are NOT  
common bermudagrass or  
“yellow dog” 419**





**NOT talking about  
contamination from edge**









# Diligence During Renovation



**UDBG**



**Unknown**



**Surround**



**Samples Submitted to WDC - Spring 2017**

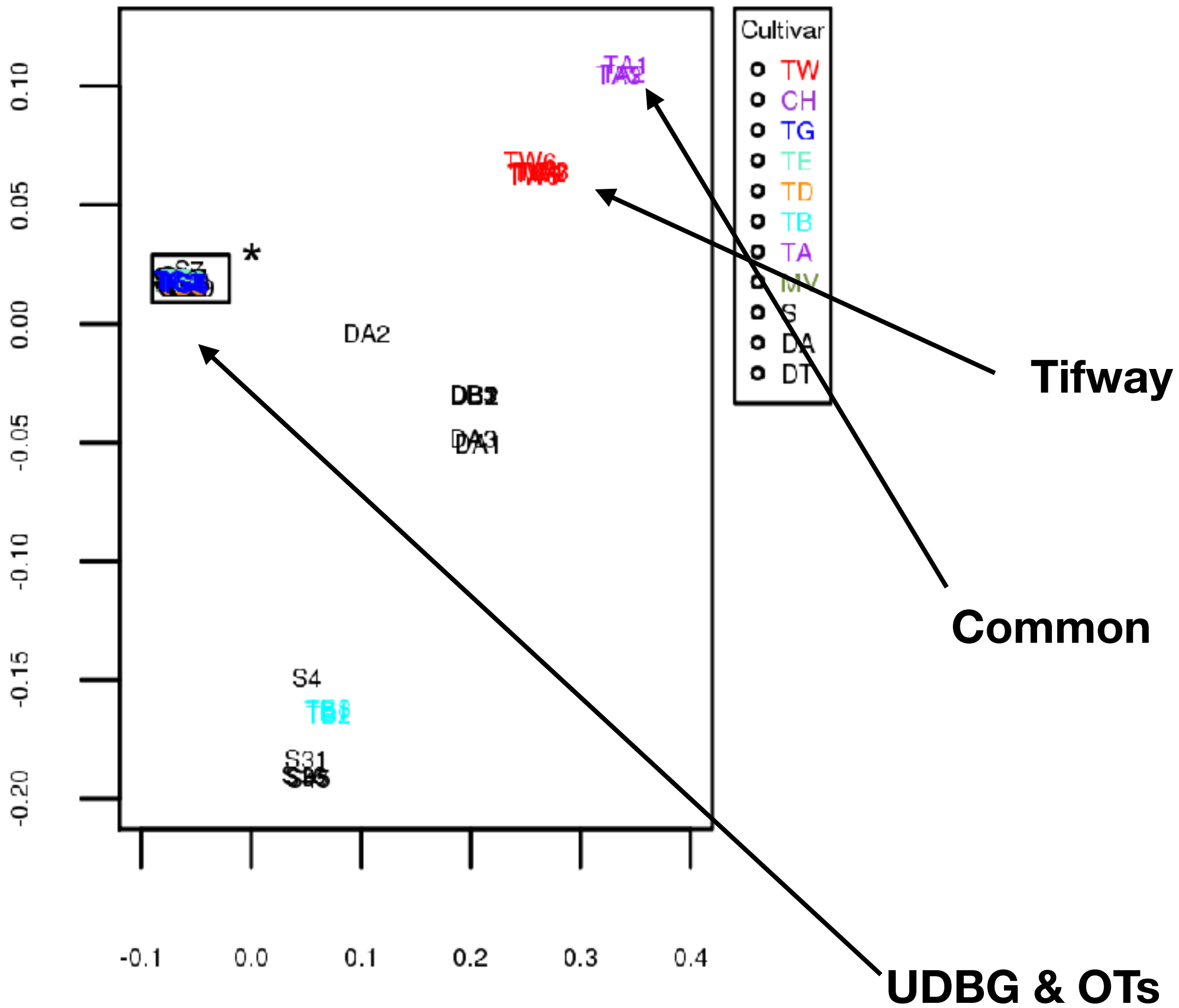


# **Genotyping-by-Sequencing (GBS)**

- **Technique to identify unique genetic markers**
- **Divides DNA into small segments**
- **High-throughput sequencing (270 million reads)**
- **Included:**
  - **TifEagle, MiniVerde, and Champion standards**
  - **Common bermudagrass and Tifway**
  - **All OT samples in our collection as well as desirables from each course visited**



MDS Component 2



MDS Component 1



# GBS Results

- Only 5 Its were genetically unique
- Could NOT identify majority from parent cultivar
- Grasses are genetically similar and differences in phenotype may be related to gene expression



RESEARCH

Open Access



# Genotypic and phenotypic evaluation of off-type grasses in hybrid Bermudagrass [*Cynodon dactylon* (L.) Pers. x *C. transvaalensis* Burt-Davy] putting greens using genotyping-by-sequencing and morphological characterization

Eric H. Reasor<sup>1\*</sup>, James T. Brosnan<sup>2</sup>, Margaret E. Staton<sup>3</sup>, Thomas Lane<sup>3</sup>, Robert N. Trigiano<sup>3</sup>, Phillip A. Wadl<sup>4</sup>, Joann A. Conner<sup>5</sup> and Brian M. Schwartz<sup>6</sup>

## Abstract

**Background:** Interspecific hybrid bermudagrass [*Cynodon dactylon* (L.) Pers. x *C. transvaalensis* Burt-Davy] is one of



# **Question #1 - What are they?**

- Triploid hybrids from 'Tifgreen' family**
- High degree of genetic similarity**
  - Would suggest these are mutation rather than contaminants → but does that even matter?**
- Differences could be related to gene expression**



## **Question #2**

**Is this problem worse in a specific cultivar?**



**It depends...**



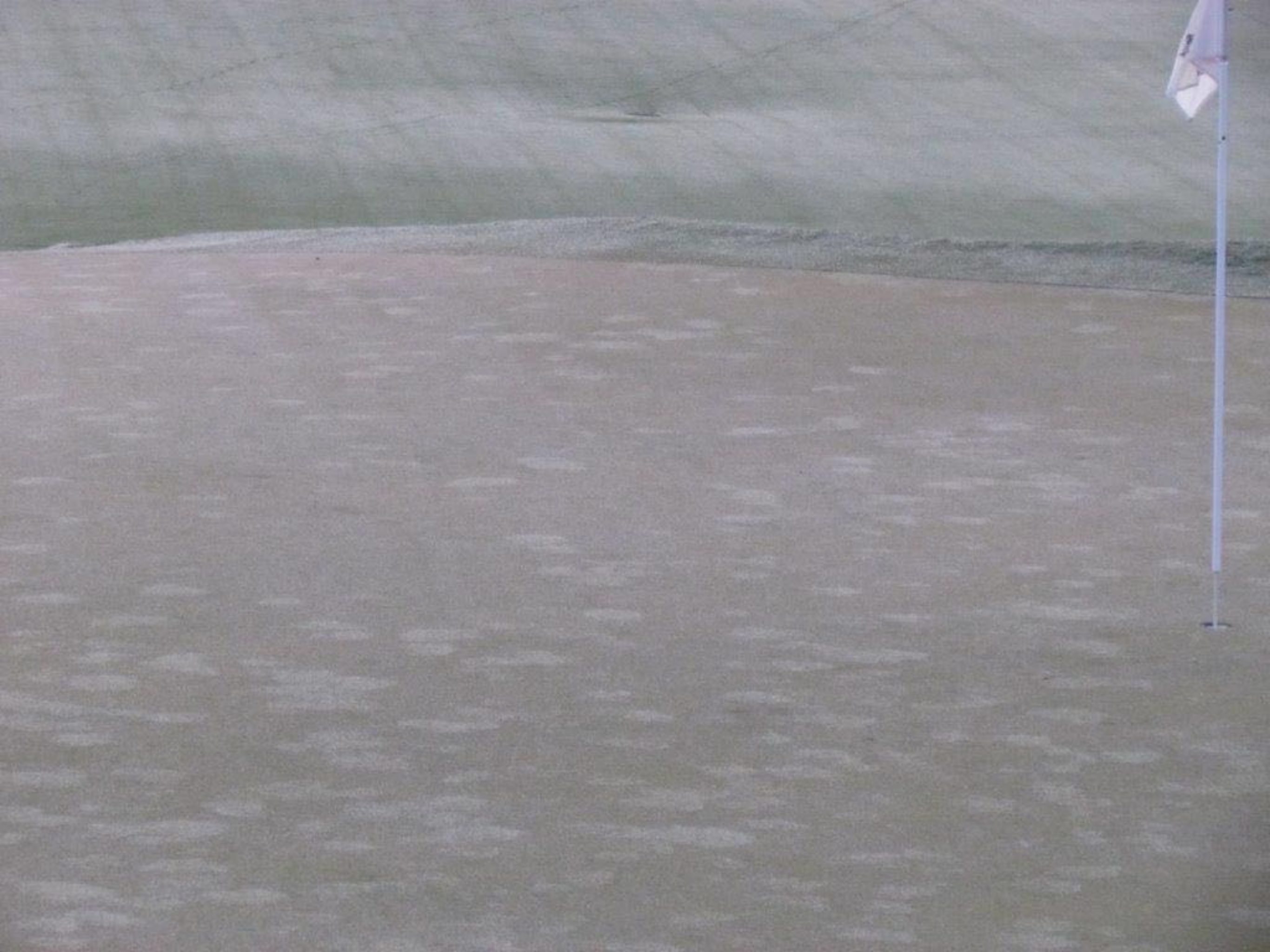
# Off-Type Sampling

- **Courses established to Champion, MiniVerde, TifEagle, and Sunday**





















**Marketshare?  
Sampling?**



# Off-Type Sampling

- **Ages <1 year to 17 years**



# Off-Type Sampling

- **Array of previous grasses (prior to current UDBG)**
- **Tifgreen (328) to creeping bentgrass**



# Off-Type Sampling

- **Array of establishment**
- **Single Roundup application to fumigation and new mix**















**Issue when moving from one  
UDBG to another**





# **Question #2 - Cultivar?**

- Seen in all commercial cultivars sampled**
  - More in Champion, could be a function of marketshare in transition zone**
- Seen on greens of varied history (previous grass, renovation technique)**



## **Question #3**

**How do I start off on the correct foot?**



**NEVER STOP  
LEARNING**

---





# Visit other greens in your area

## Talk about the OT Problem





# Visit sod producers

## Talk about the OT Problem







**A function of the quality control  
standards of growers**





**Georgia Crop**

Improvement Association

**CERTIFIED “BLUE TAG”  
TURFGRASS  
PRODUCTION MANUAL**



**Remember**  
**You're the customer**



**As a customer**  
**You have the power**





# Inspect Fields Yourself

- Visit when dew is present
- ID differences in color, texture, seed heads, etc.
- Visit just prior to next mowing
- Overall sanitation





# Learn about the field history

- Age of the field
- Establishment method
- Planting material
- History of pesticide use





# Ask Questions

- How often are the fields inspected?
- What are the roguing/eradication methods?
- How often are off-types removed?
- How often are new fields left fallow, re-planted elsewhere?
- For example, TifEagle growers limited to 5 years before required to re-establish foundation material



**NEVER STOP  
LEARNING**

---







**Explore non-conventional  
production**



# **Non-Conventional Production**

- Material produced using your management strategies**
- May help ID more off-types**
- High upfront cost, but well worth it**











**Do not hesitate to**  
**Reject plant material**















**Regularly scout  
your greens**





**If it looks different,  
remove it**

**Regularly scout  
your greens**



# **Question #3 - Starting Right?**

- Have the conversation**
  - Other superintendents, sod producers, etc.**
- Carefully select a producer you're comfortable with**
  - Ask questions about production process, OT issue**
  - Visit fields to inspect for yourself**
  - Non-conventional production?**
- Reject plant material on-site that looks off**
- Scouting starts immediately after sprigging and never stops**



## **Question #4**

**I have off-types. Now what?**





**Lack of desirable  
“control” options**



A close-up photograph of a lawn. The grass is green but has many brown, dead patches, indicating a problem with growth or health. In the top right corner, there is a black plastic mulch cap, which is a common tool used in landscaping to suppress weeds and retain moisture. The text "Balancing Growth Rate" is overlaid in white at the bottom of the image.

**Balancing Growth Rate**



# Greenhouse Experiments

## Knoxville, TN

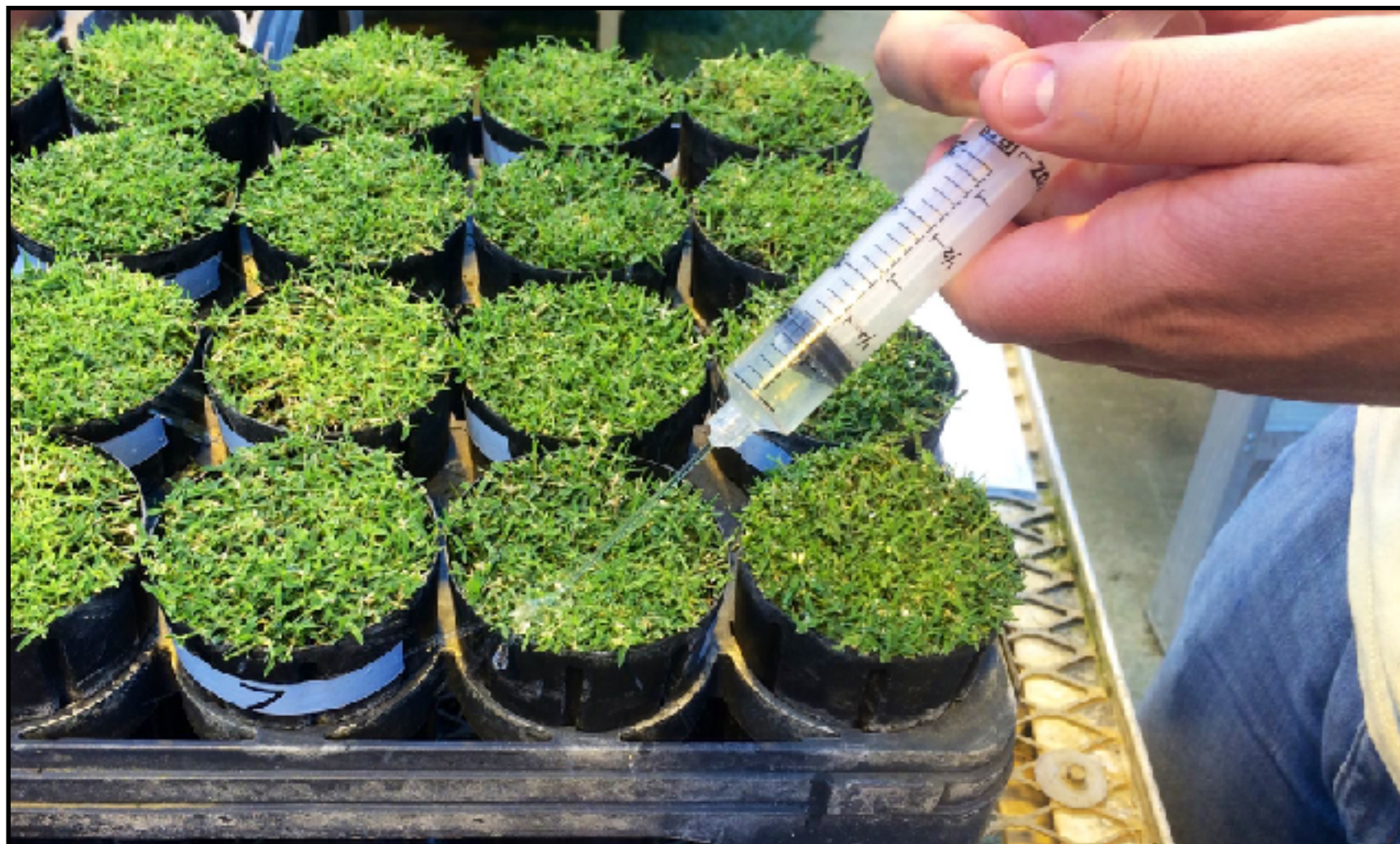


- ‘Champion’, ‘MiniVerde’, ‘TifEagle’, and 3 off-type grasses
- 80/20% sand/peat (USGA specifications)
- Single 3-node sprig planted 27 to 31 August 2015
- 1 cm mowing height and 0.5 lb N/M/week



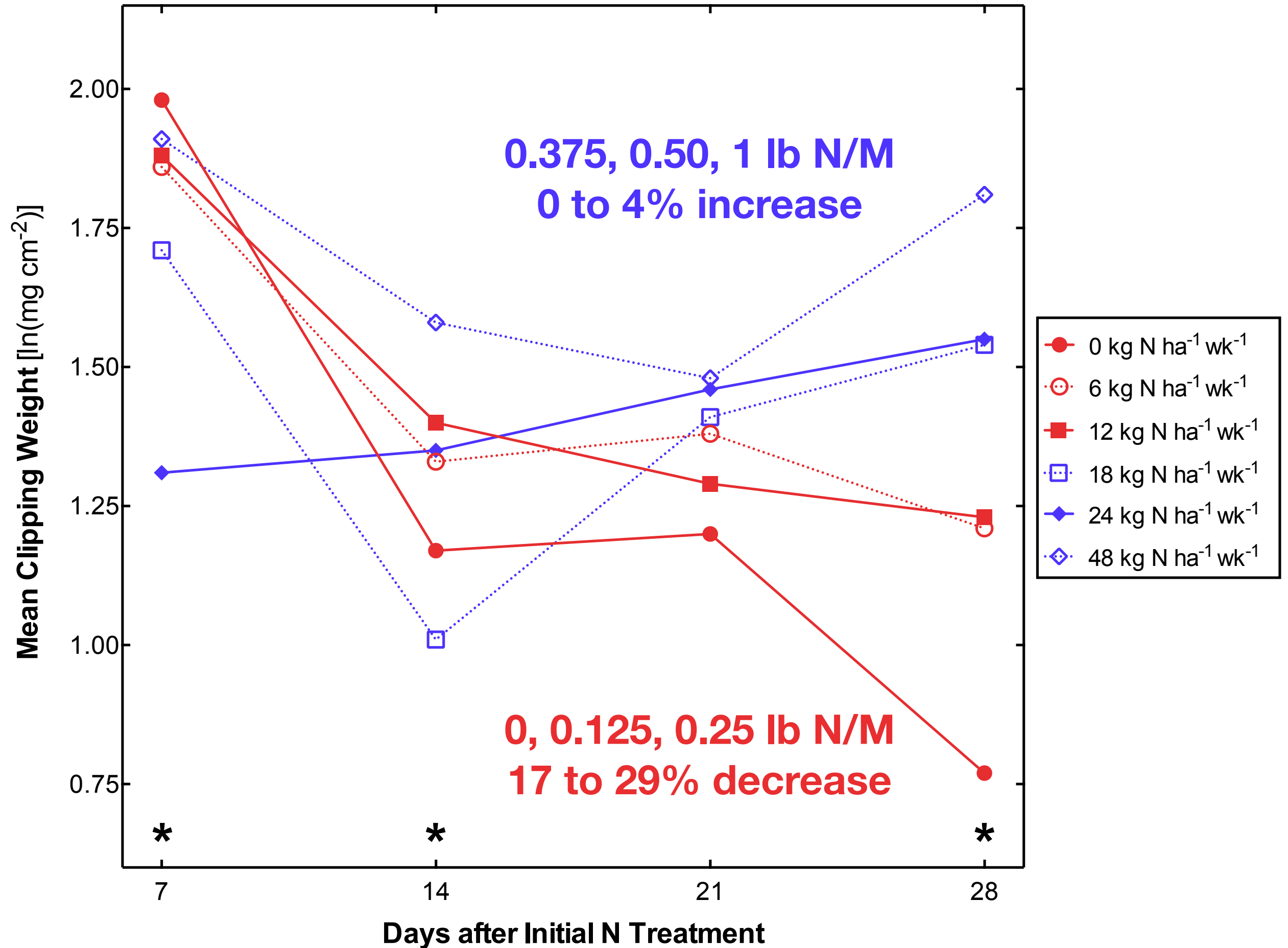
# Nitrogen Rate Response

- 0, 0.125, 0.250, 0.375, 0.5, or 1 lb N/M
- 46-0-0 micro-prill dissolved in water
- Clippings harvested 7, 14, 21, and 28 days after initial treatment (DAIT)



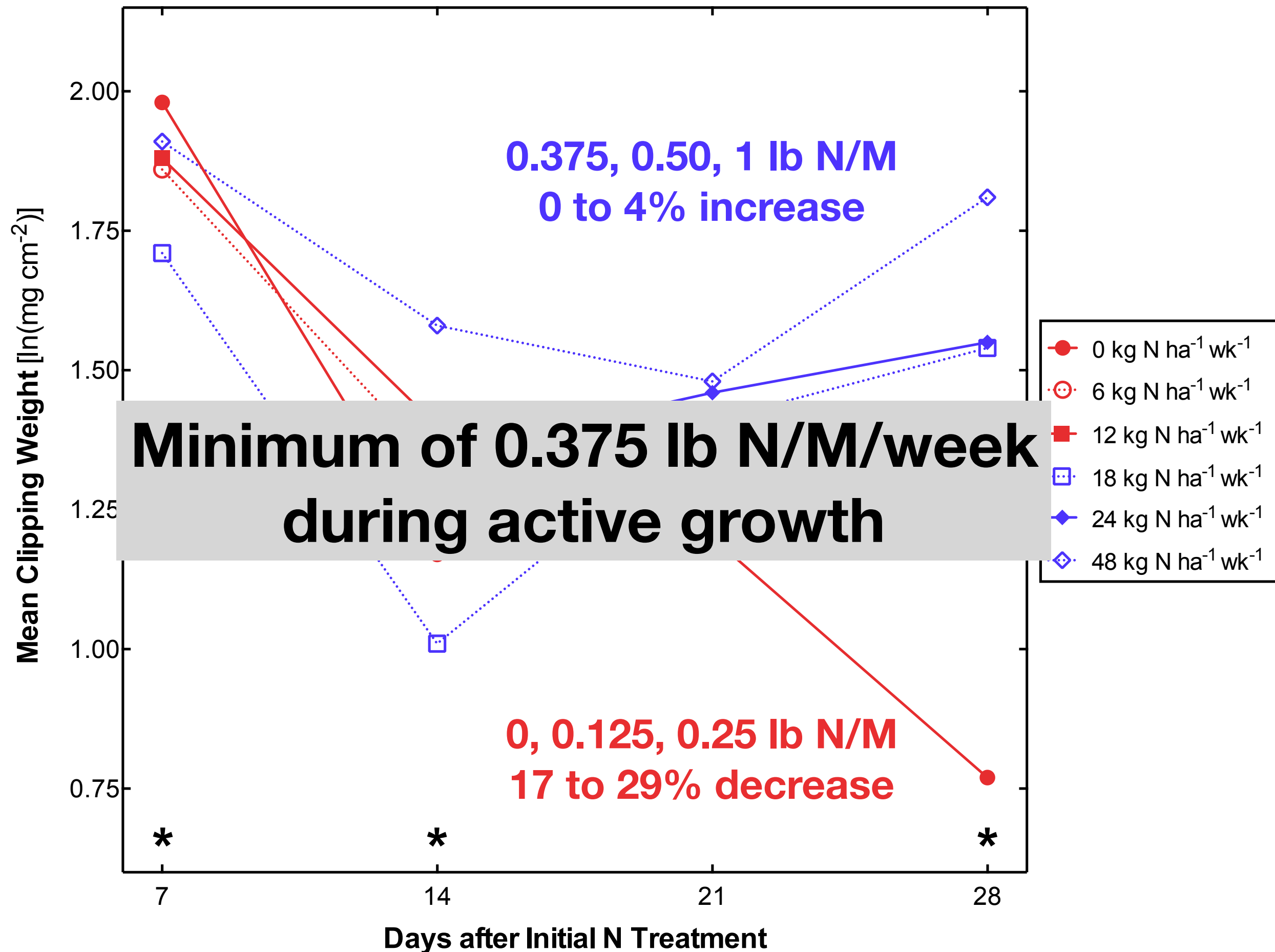


# N Rates and Days After Treatment





# N Rates and Days After Treatment





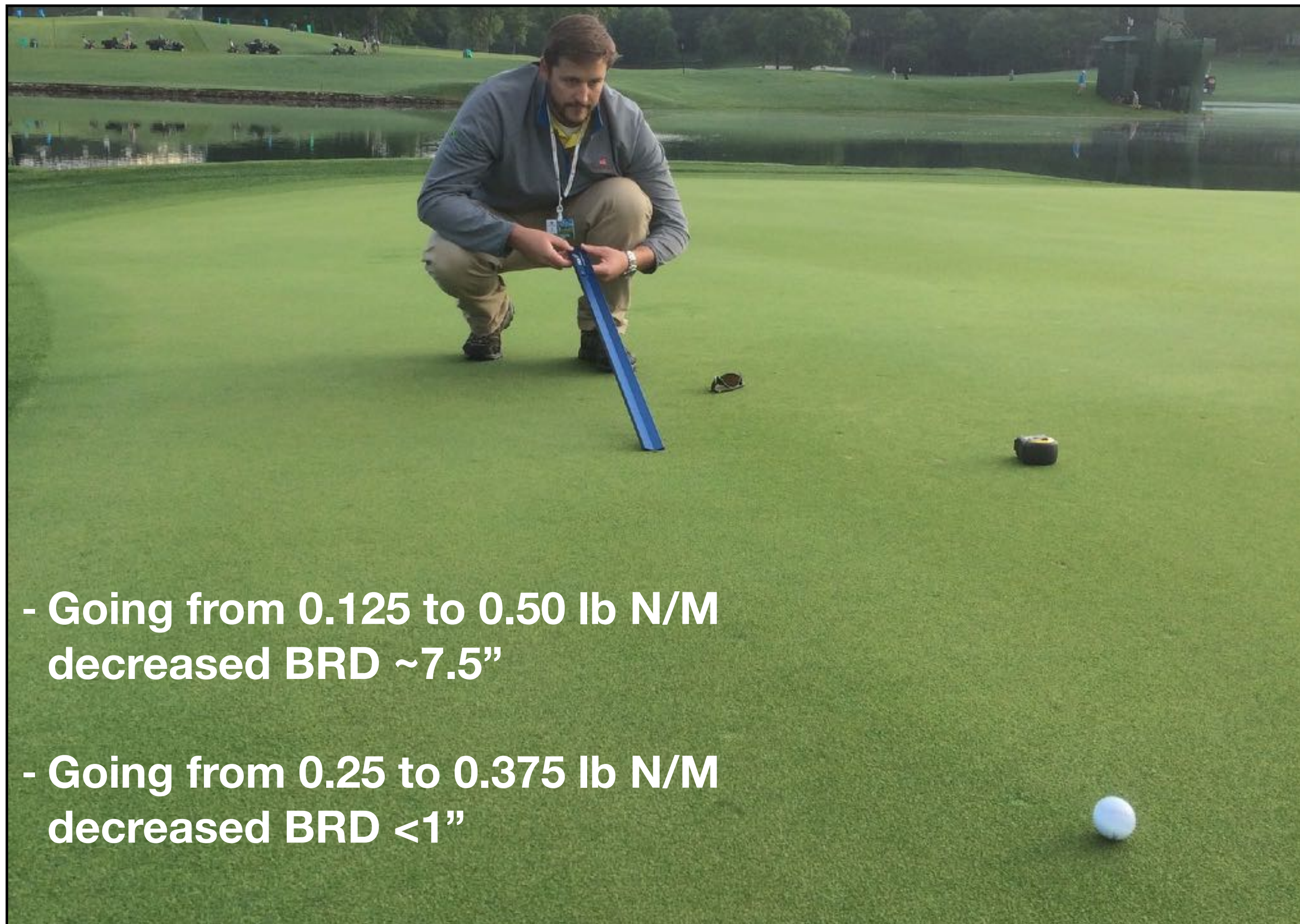


**“Worse when greens are pushed”**

**Reducing N to improve green speed**

**Will just make aesthetic contrast worse**





- Going from 0.125 to 0.50 lb N/M  
decreased BRD ~7.5"
- Going from 0.25 to 0.375 lb N/M  
decreased BRD <1"



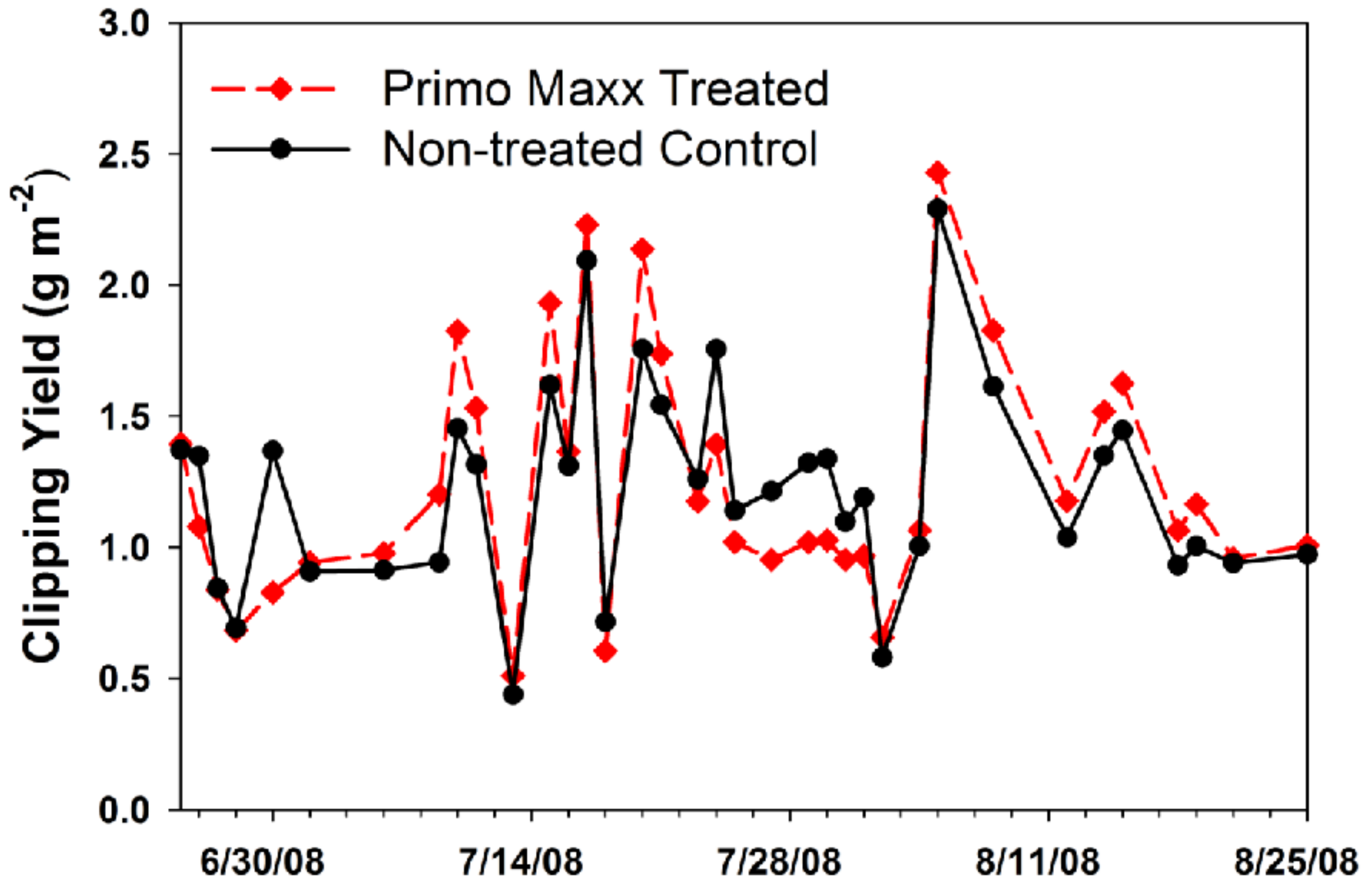


**What about PGRs?**



# The Biggest Challenge with PGRs

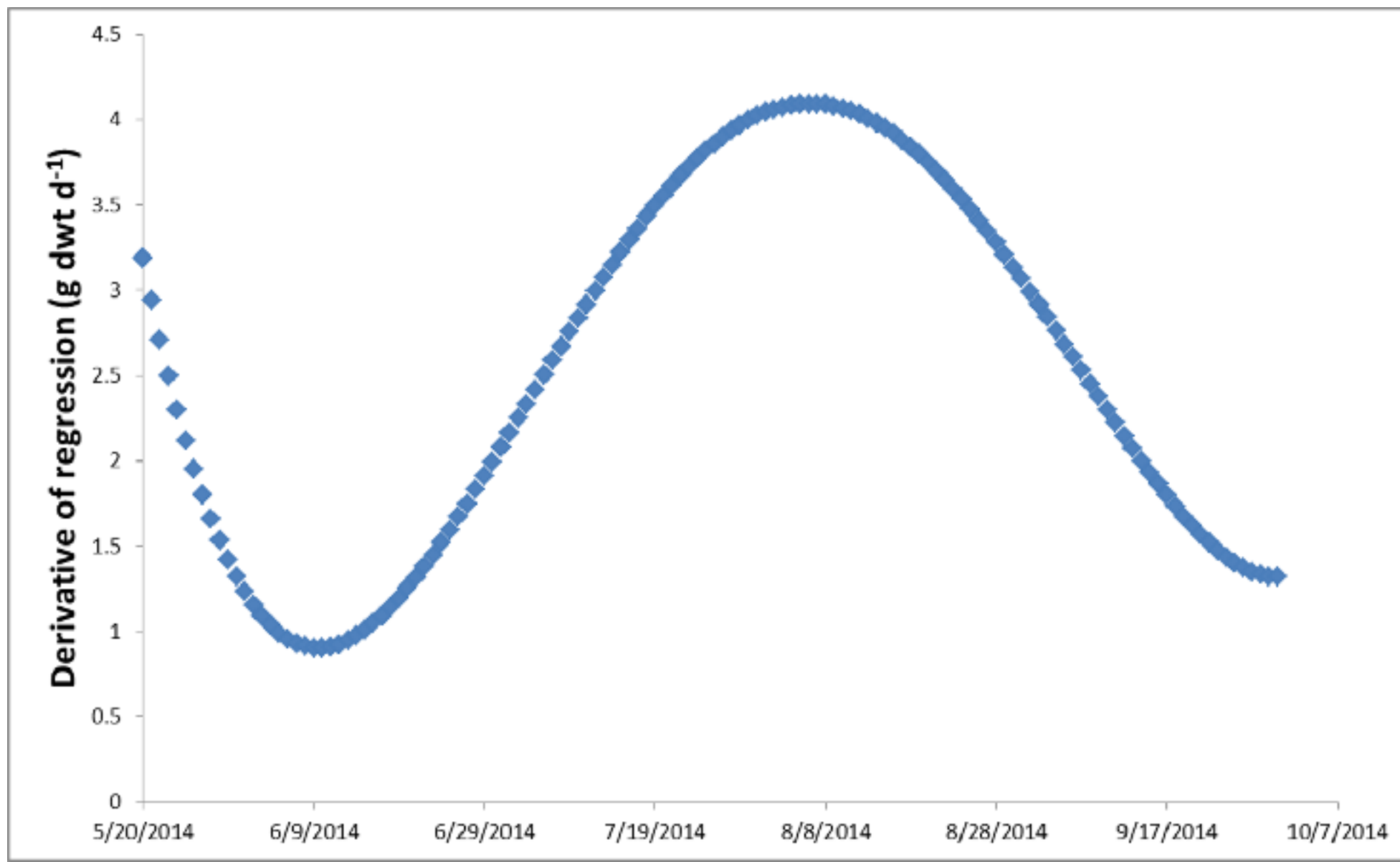
**Its Hard to Know if They Are Working**





# Soil nitrogen mineralization confounds PGR performance

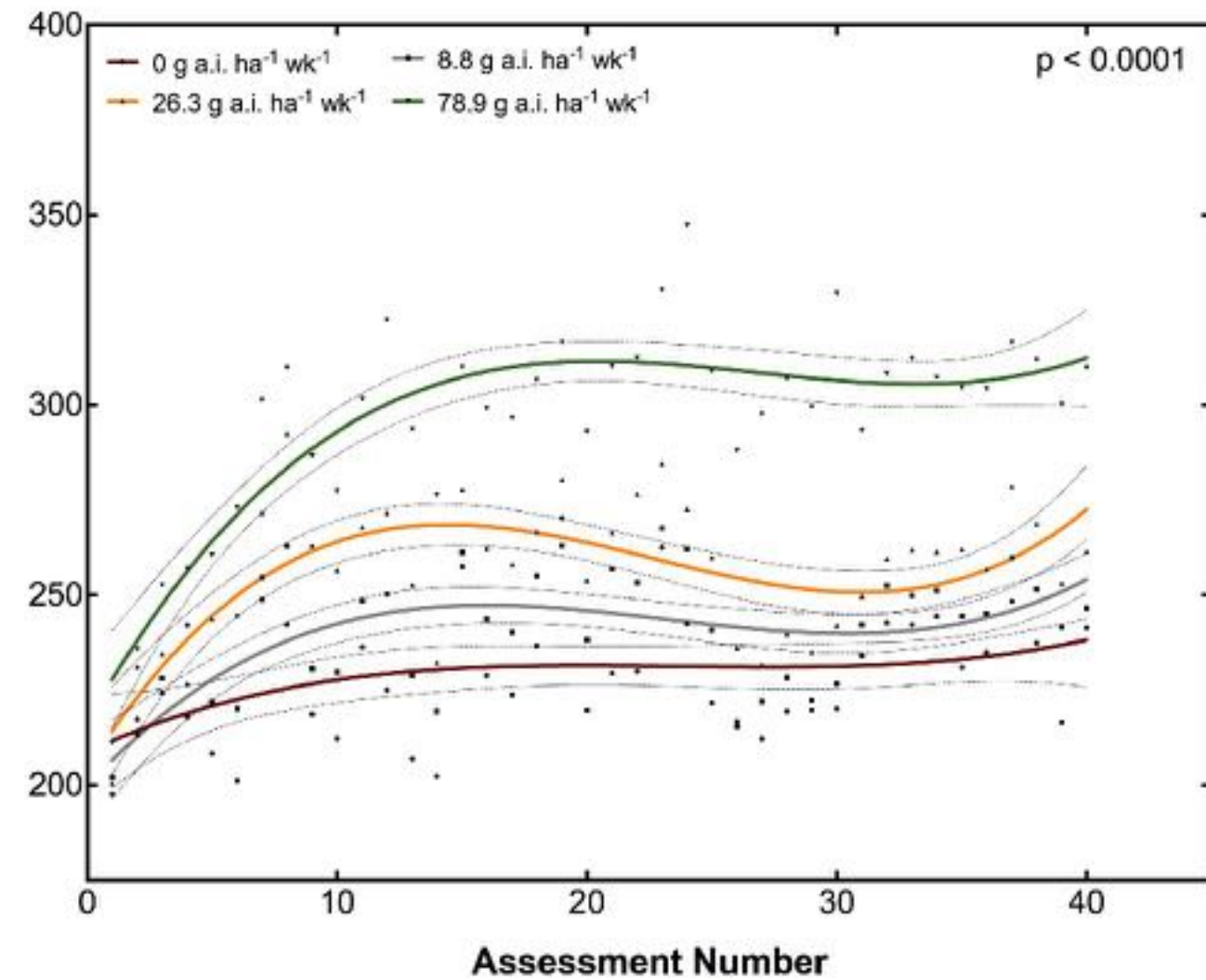
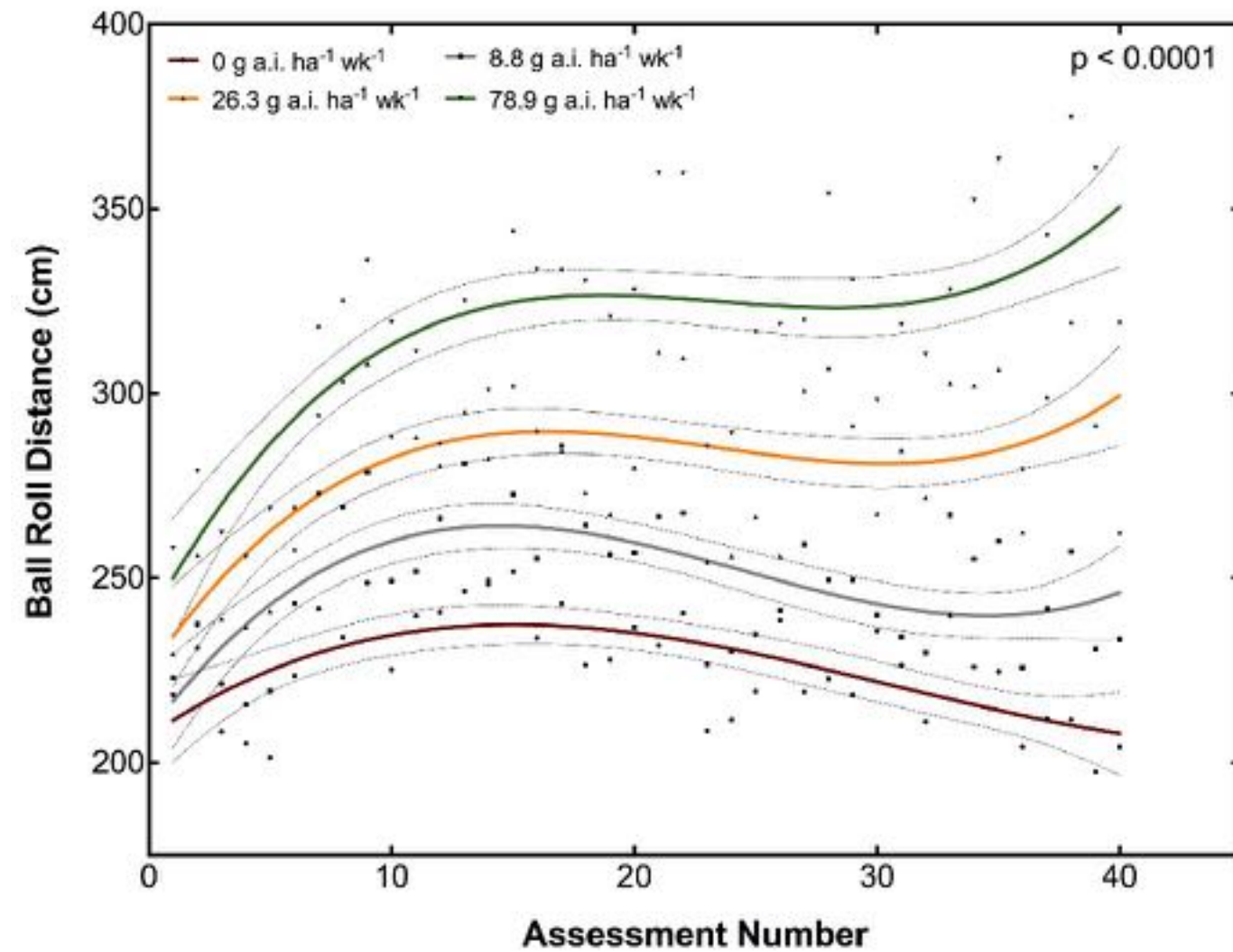
- Absolute clipping yield vs relative yield
- Greatest in warm and moist soils



Slide courtesy  
of Dr. Bill  
Kreuser, UNL



# Ball roll distance of 'MiniVerde' in response to weekly applications of Primo at 0, 1, 3, or 9 fl oz/A



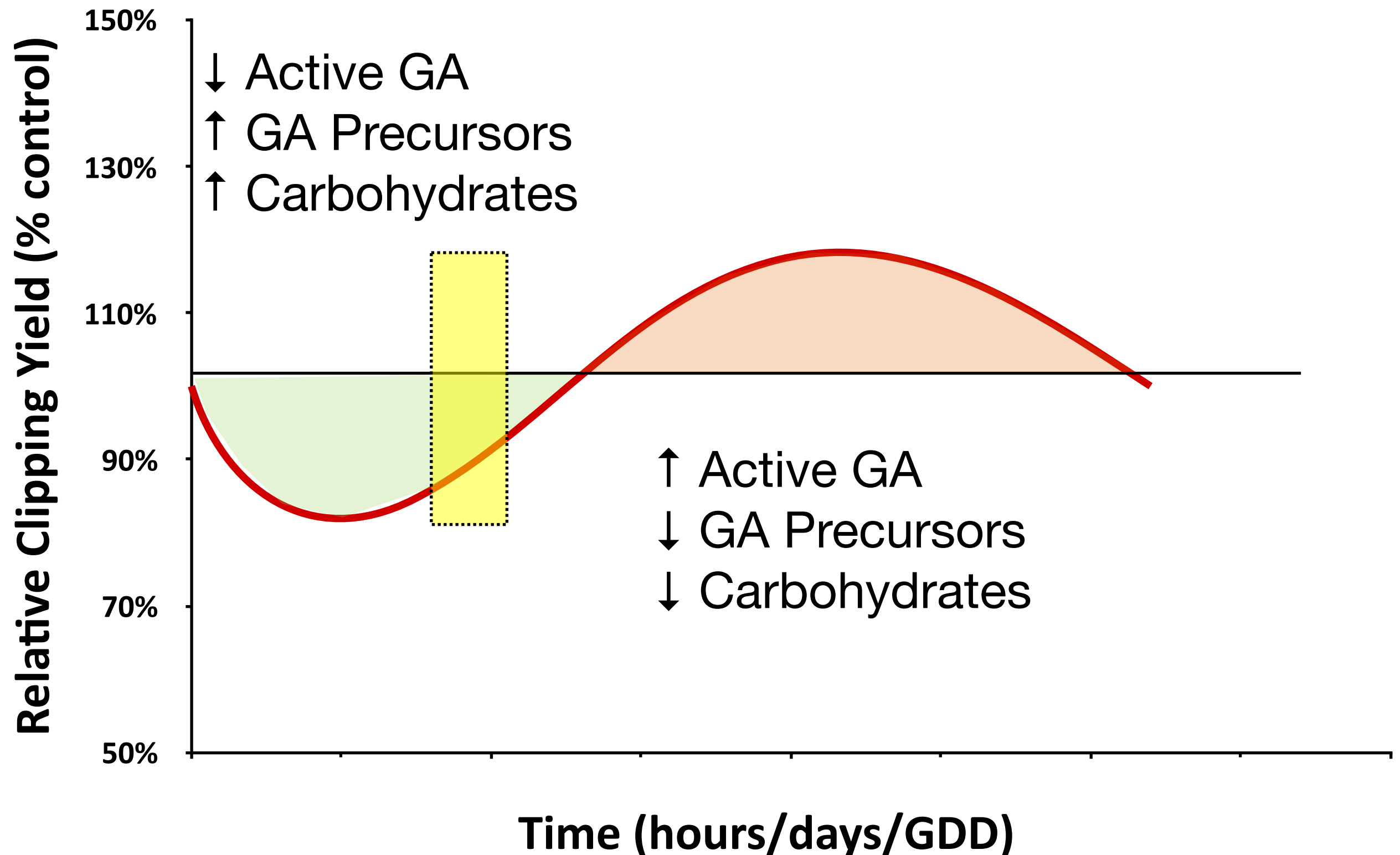




**There is a cost to over-regulating greens**



# Generalized PGR Response to Turf





# Goals for a PGR Program

- **Sustain growth suppression for the season**
- **Avoid too much growth suppression**
- **Avoid wasting money**
  - **Too frequent applications**
  - **Too infrequent applications**





**Differential Response to Primo MAXX 14 DAT**



**Unbalanced growth across a green**



**Re-apply PGR  
(or increase rate)**



**This use causes over-regulation  
making issue more apparent**









# Growing Degree Days

- **Measure of heat accumulation**
- **Average temperature compared to a pre-specific base**



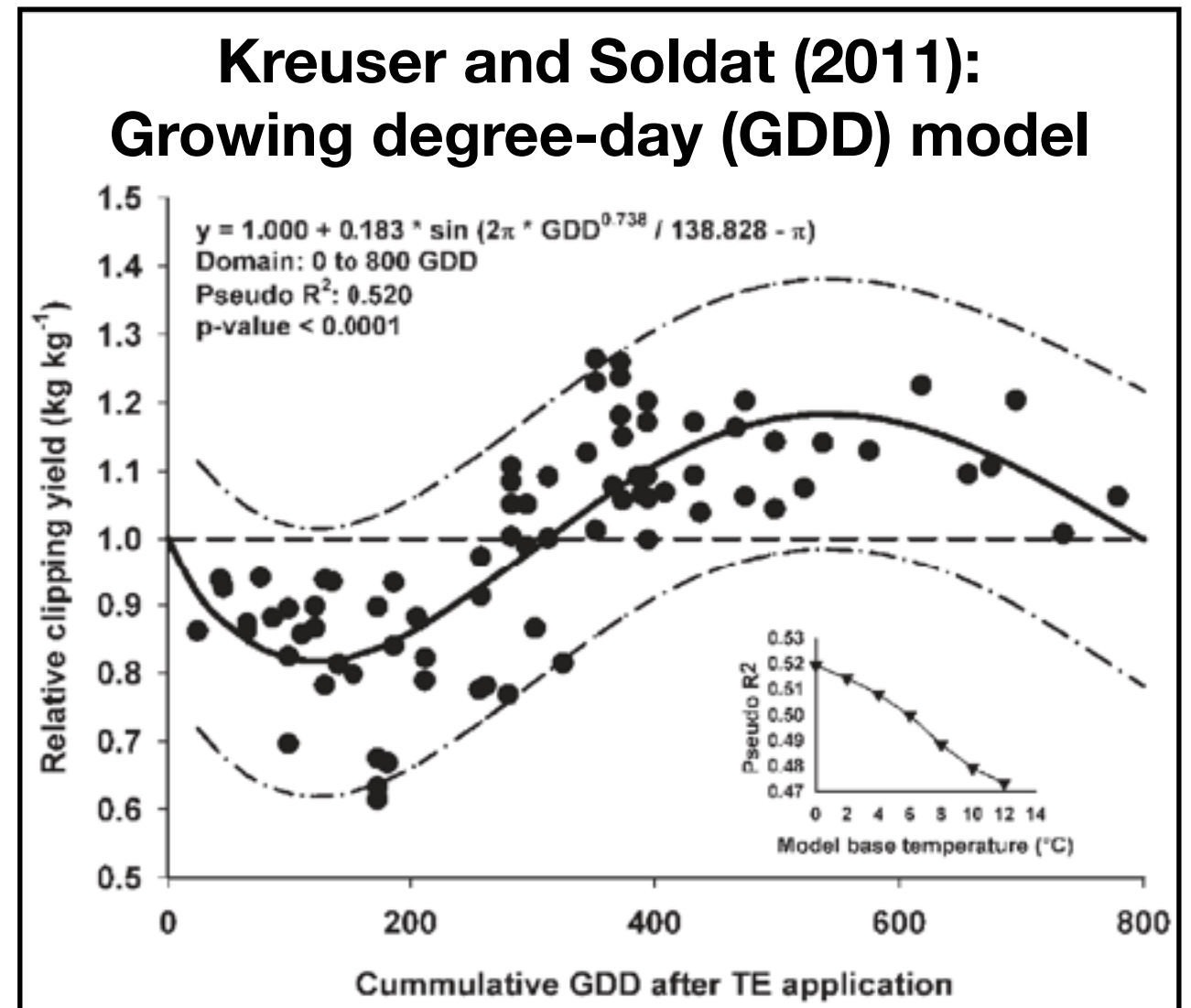
# Example

DAY	HIGH TEMP (F)	LOW TEMP (F)	AVERAGE (F)	BASE TEMP (F)	GDD
SUNDAY	80	60	70	50	20
MONDAY	70	50	60	50	10
TUESDAY	75	55	65	50	15
			TOTAL		45



# GDD Based PGR Applications

- For creeping bentgrass putting surfaces
- Developed by Dr. Bill Kreuser at University of Nebraska and Dr. Doug Soldat at Wisconsin
- Target re-application at 200 GDD (base temp 32 F)
- Research on-going to develop similar model for UDBG —> **Bent model does not apply**



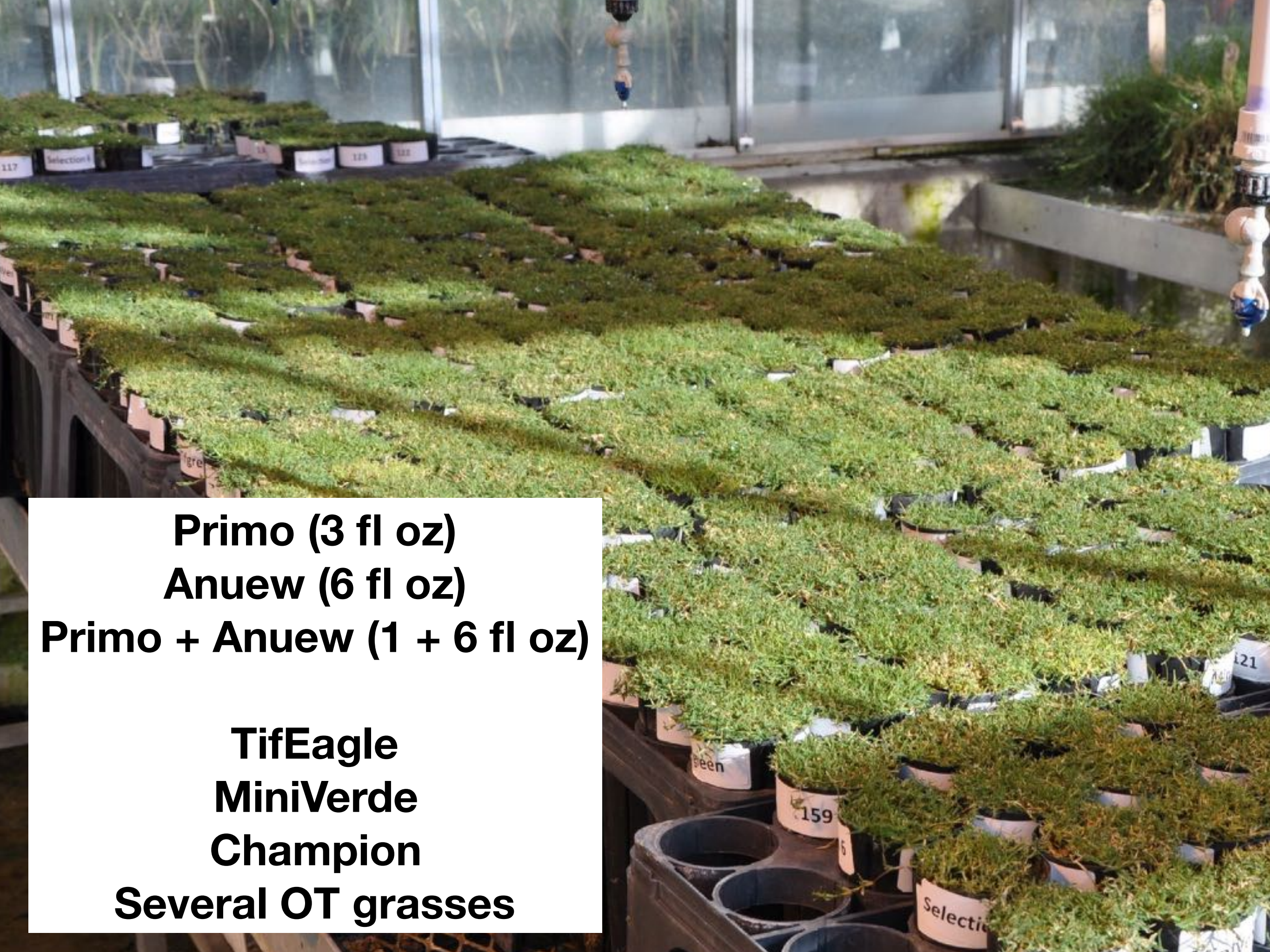


# Anuew

- Prohexadione-Ca
- Late GA inhibitor, similar site as Primo MAXX
- On-golf course demonstrations in 2016 showing effects on UDBG greens







**Primo (3 fl oz)**  
**Anuew (6 fl oz)**  
**Primo + Anuew (1 + 6 fl oz)**

**TifEagle**  
**MiniVerde**  
**Champion**  
**Several OT grasses**



# **Anuew Results - Greenhouse**

- Less overall regulation with Anuew 7 to 21 DAT**
- Less rebound with Anuew for 21 to 28 DAT**
- Mixing Anuew + Primo lessened rebound compared to Primo alone**
- Required field confirmation**



# 2017 PGR Research on UDBG

- **Field trials conducted in June, July, and August 2017**
  - **East TN AgResearch & Education Center.**  
**Knoxville, TN - 'MiniVerde'**
  - **R.R. Foil Plant Science Research Center.**  
**Starkville, MS - 'TifEagle'**
  - **Hope Valley Country Club.**  
**Durham, NC - 'Champion'**
- **On-site weather stations at each locations used to calculate GDD accumulation after application using a base temperature of 10 C**



# Growing Degree Day Models for Plant Growth Regulator Applications on Ultradwarf Hybrid Bermudagrass Putting Greens

E. H. Reasor, J. T. Brosnan, J. P. Kerns, W. J. Hutchens, D. R. Taylor, J. D. McCurdy, D. J. Soldat, and W. C. Kreuser\*

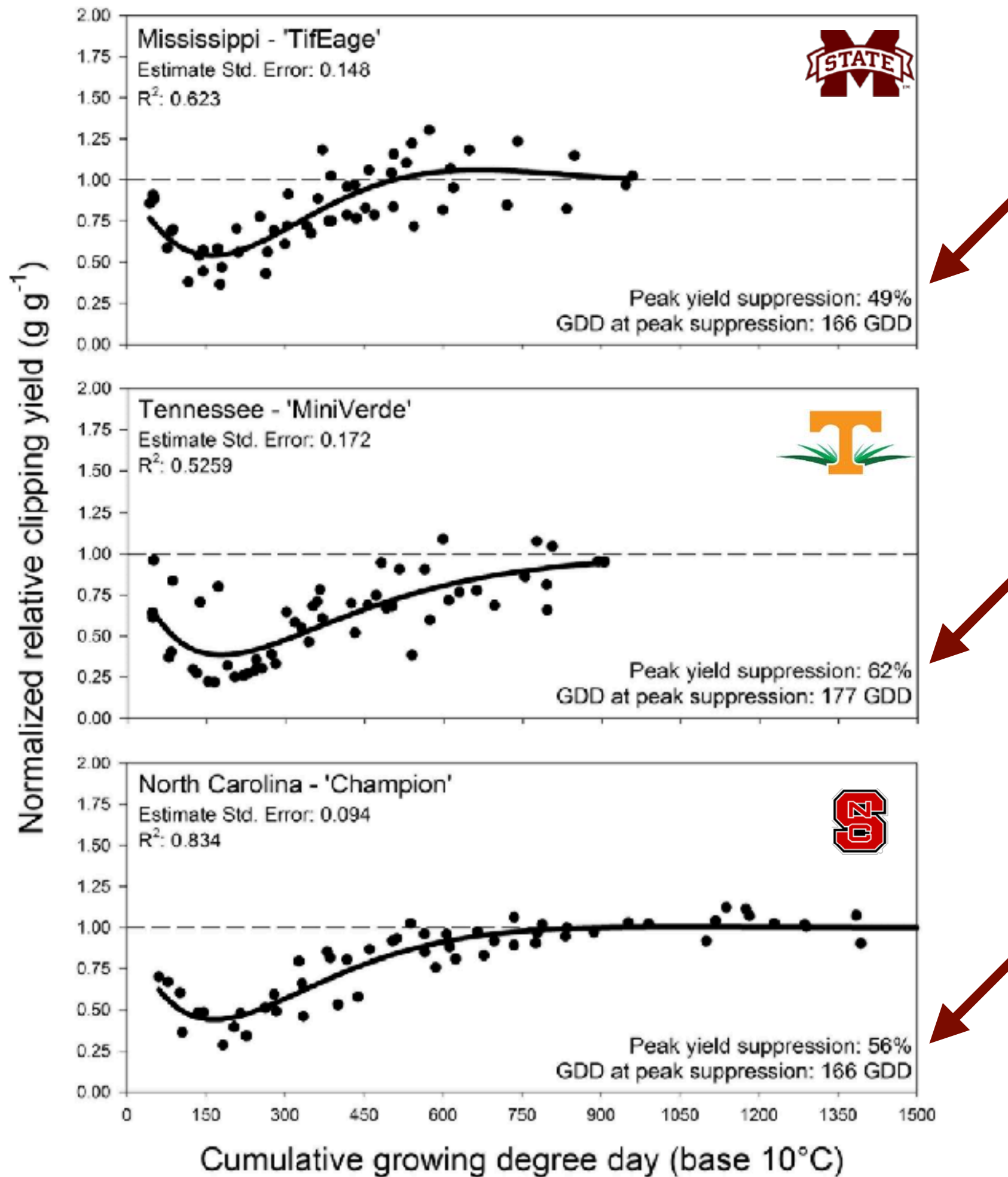
## ABSTRACT

Plant growth regulators (PGRs) are commonly applied to ultradwarf hybrid bermudagrass [*Cynodon dactylon* (L.) Pers. × *C. transvaalensis* Burt-Davy] putting greens during the growing season. Trinexapac-ethyl (TE) and prohexadione-Ca (PH) are PGRs that inhibit gibberellic acid biosynthesis and are used to reduce clipping yield and improve turfgrass visual quality. Growing degree day (GDD) models have optimized the timing of PGR reapplications to creeping bentgrass (*Agrostis stolonifera* L.) putting greens, but no information is available regarding proper PGR reapplication timing on bermudagrass putting greens. The objective of this research was to develop a GDD model to determine optimal TE and PH appli-

E.H. Reasor and J.D. McCurdy, Dep. of Plant and Soil Sciences, Mississippi State Univ., 117 Dorman Hall, 32 Creelman St., Box 9555, Mississippi State, MS 39762; J.T. Brosnan and D.R. Taylor, Dep. of Plant Sciences, Univ. of Tennessee–Knoxville, 2431 Joe Johnson Dr., 252 Ellington Plant Sciences Building, Knoxville, TN 37996; J.P. Kerns and W.J. Hutchens, Dep. of Crop and Soil Sciences, North Carolina State Univ., Campus Box 7620, North Carolina State Univ. Campus, Raleigh, NC 27695-7620; D.J. Soldat, Dep. of Soil Science, Univ. of Wisconsin, Madison, WI 53706; W.C. Kreuser, Dep. of Agronomy and Horticulture, Univ. of Nebraska–Lincoln, 202 Keim Hall, Lincoln, NE 68583-0915. Received 30 Jan. 2018. Accepted 24 Apr. 2018. \*Corresponding author (wkreuser2@unl.edu). Assigned to Associate Editor Douglas Karcher.

**Abbreviations:** GA, gibberellic acid; GDD, growing degree days; GDD<sub>10C</sub>, growing degree days calculated using 10°C as the base temperature; PGR, plant growth regulator; PH, prohexadione-calcium; TE, trinexapac-ethyl.



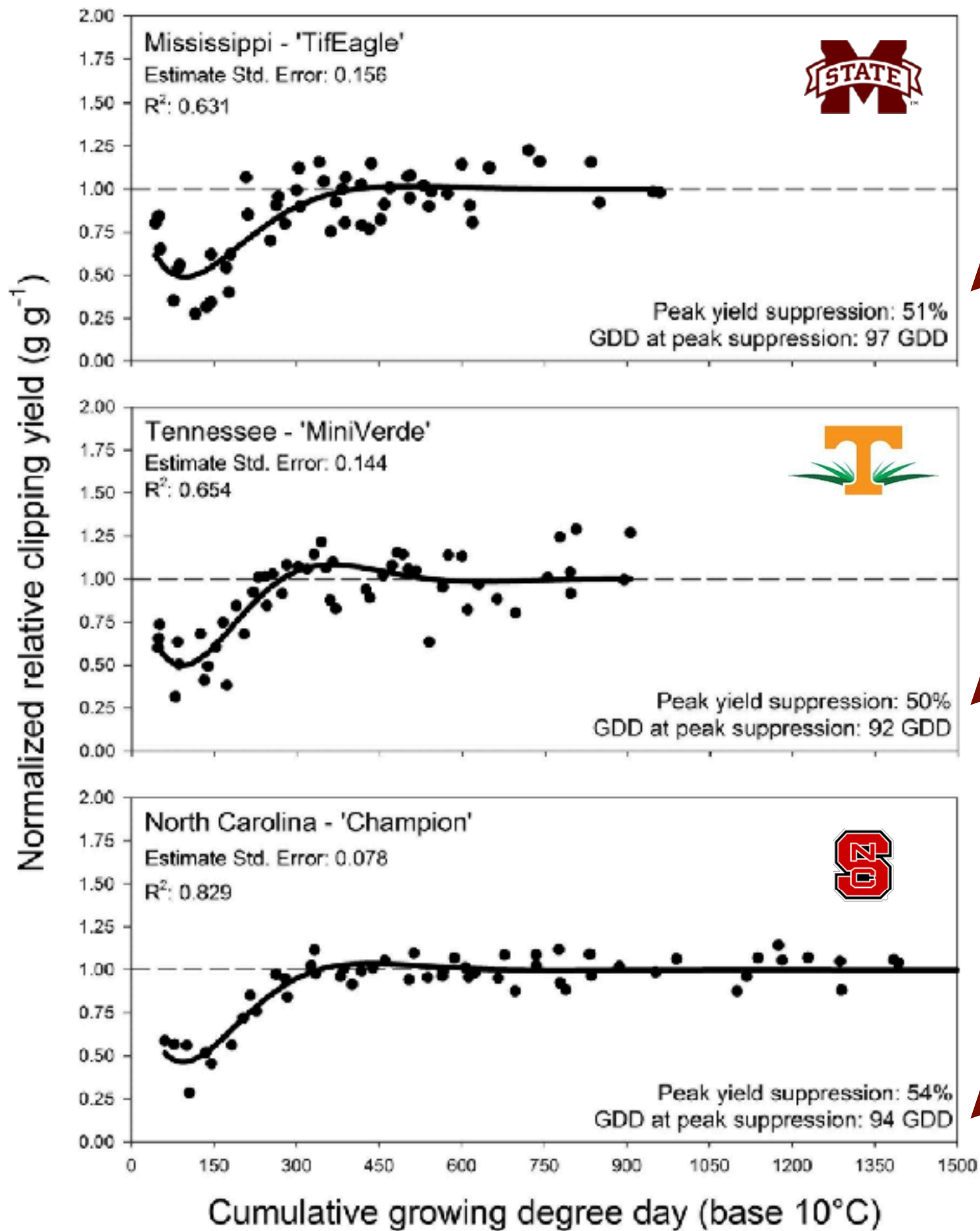




# 2017 GDD Results - Primo

CULTIVAR	PEAK SUPPRESSION (%)	GDD TO PEAK	RE-APP
CHAMPION	56	166	216
MINIVERDE	62	177	230
TIFEAGLE	49	166	216







# 2017 GDD Results - Anuew

CULTIVAR	PEAK SUPPRESSION (%)	GDD TO PEAK	RE-APP
CHAMPION	54	94	122
MINIVERDE	50	92	120
TIFEAGLE	51	97	126



# **GDD Models Fit UDBG**

- **Similarity across cultivars in time to peak regulation**
- **Optimal re-application for Primo is 220 GDD<sub>10C</sub>**
- **No rebound observed**
- **Anuew acts faster than Primo. Optimal re-application is 126 GDD<sub>10C</sub>**
- **Regulation of growth 49 to 62% with single application**



A wide, flat, green lawn, likely a golf course, with a line of trees in the background. The text is overlaid on the lower portion of the image.

**You're applying Primo at 3 fl oz/A per week in August**



A wide, flat, green lawn, likely a golf course, with a line of trees in the background. The grass is a vibrant green, and the trees are dark green with some bare branches visible. The sky is not visible.

**You're applying Primo at 3 fl oz/A per week in August**

**Each application reduces growth 62%**




A wide, flat, green lawn, likely a golf course, with a line of trees in the background. The grass is a vibrant green, and the trees are dark green with some bare branches. The sky is not visible.

**You're applying Primo at 3 fl oz/A per week in August**

**Each application reduces growth 62%**

**...and takes multiple weeks to recover**



An aerial photograph of a golf green. The green is mostly a uniform green color, but it is covered with numerous small, irregular patches of yellowish-brown. These patches are scattered across the entire surface, with some areas appearing more densely affected than others. The patches likely represent damage to the grass, possibly from a disease or pest, which has not yet fully recovered.

**Highly regulated when pathogens are most active...  
no recovery from damage**



**Unbalanced growth across a green**



**Limited Recovery  
from Disease**

**Re-apply PGR  
(or increase rate)**

**Vicious Spiral of Bad Decisions**







# Stress Meter

**Panic  
Attack!**

**Anxiety**

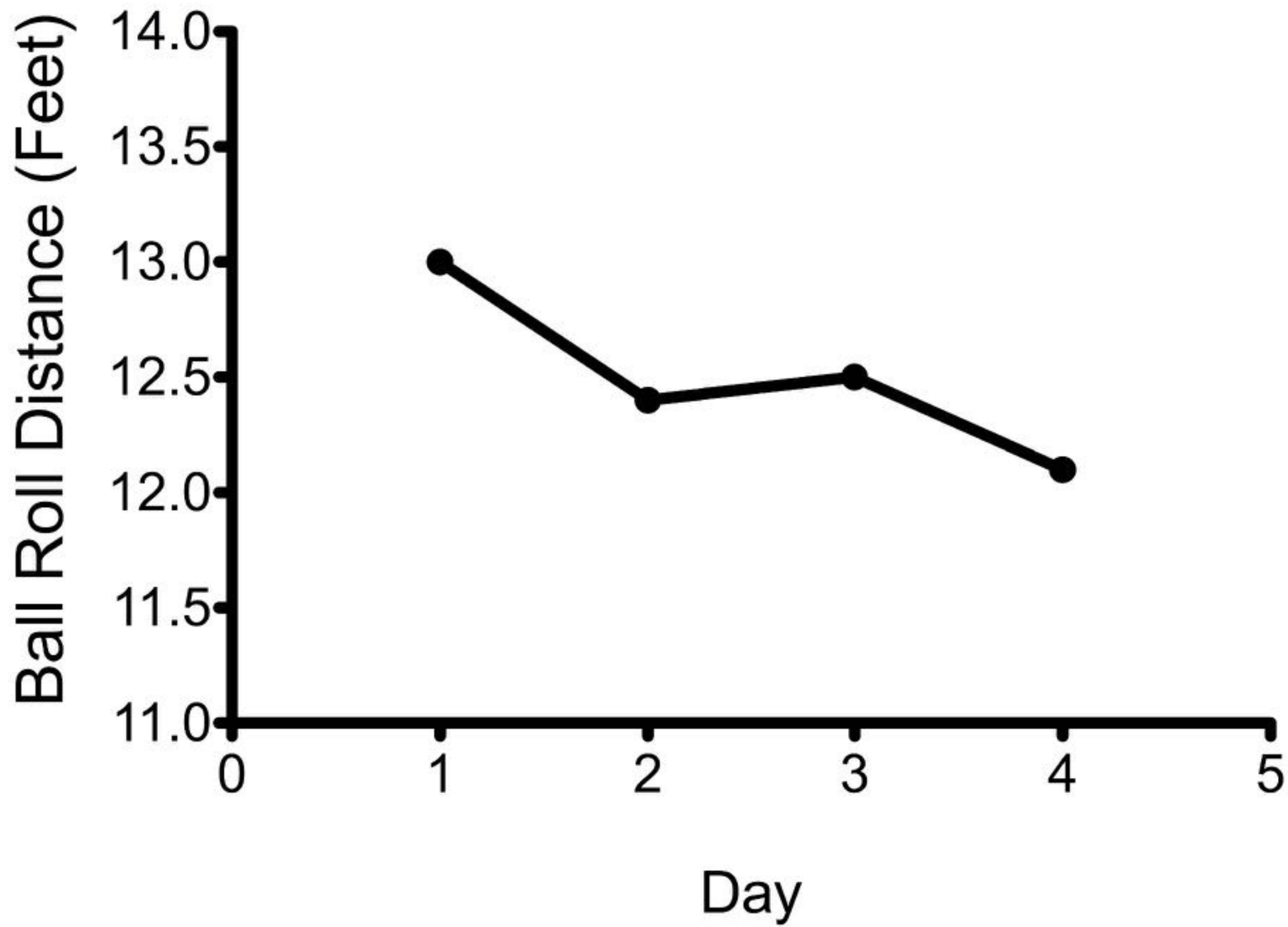
**Stressed**

**Coping**

**Relaxed**









# Stress Meter

**Panic  
Attack!**

**Anxiety**

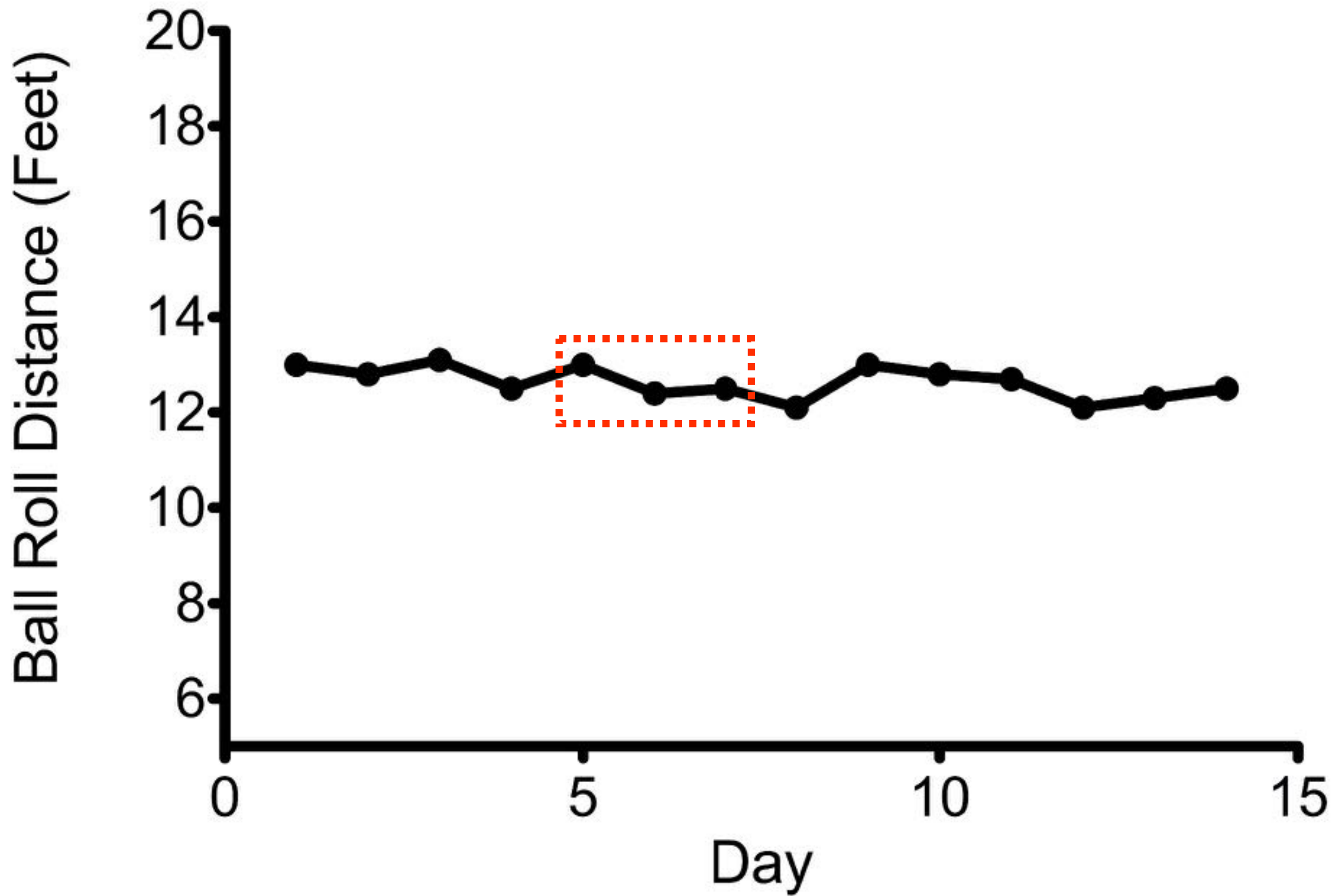
**Stressed**

**Coping**

**Relaxed**

**Detach**







# 2018 GDD Research

- TifEagle, MiniVerde, and Champion
- Project began in June 2018 and is still active



## - Treatments

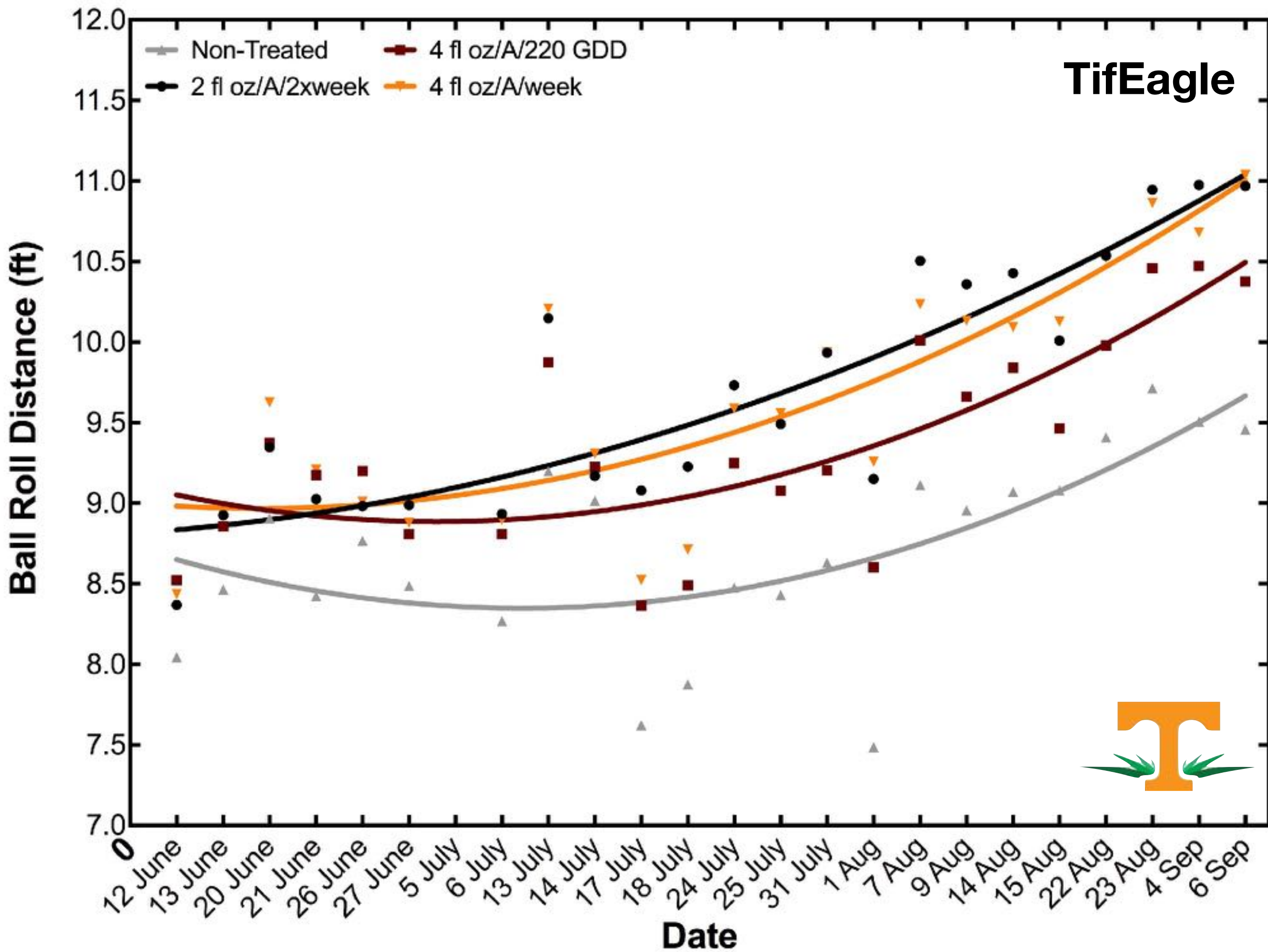
- Primo at 4 fl oz/A weekly
- Primo at 2 fl oz/A (2x week)
- Primo at 4 fl oz/A every GDD<sub>10C</sub>
- Non-treated control



- Ball roll (2x per week, 3x per day), TQ, clipping yield, disease incidence

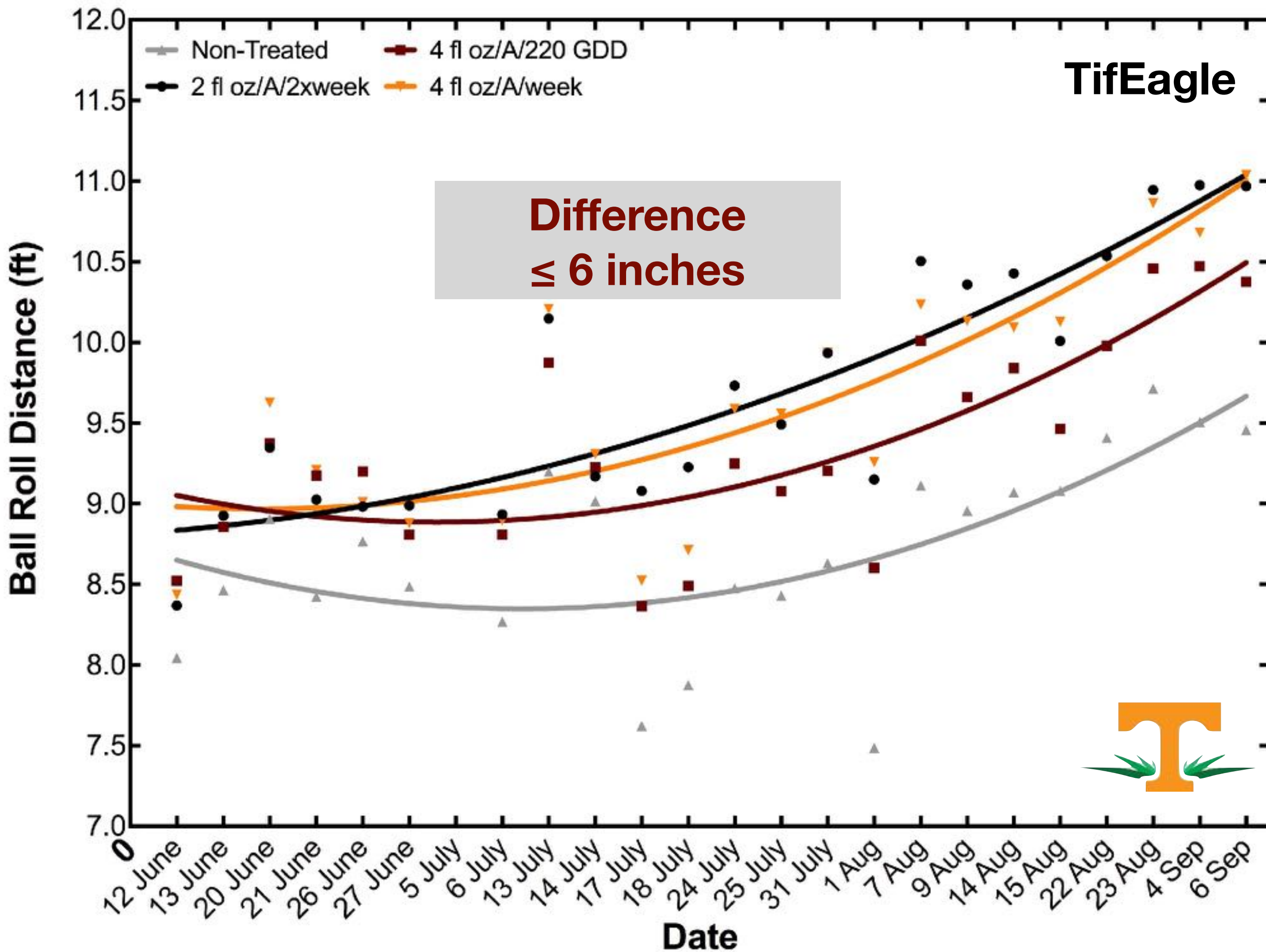


**TifEagle**

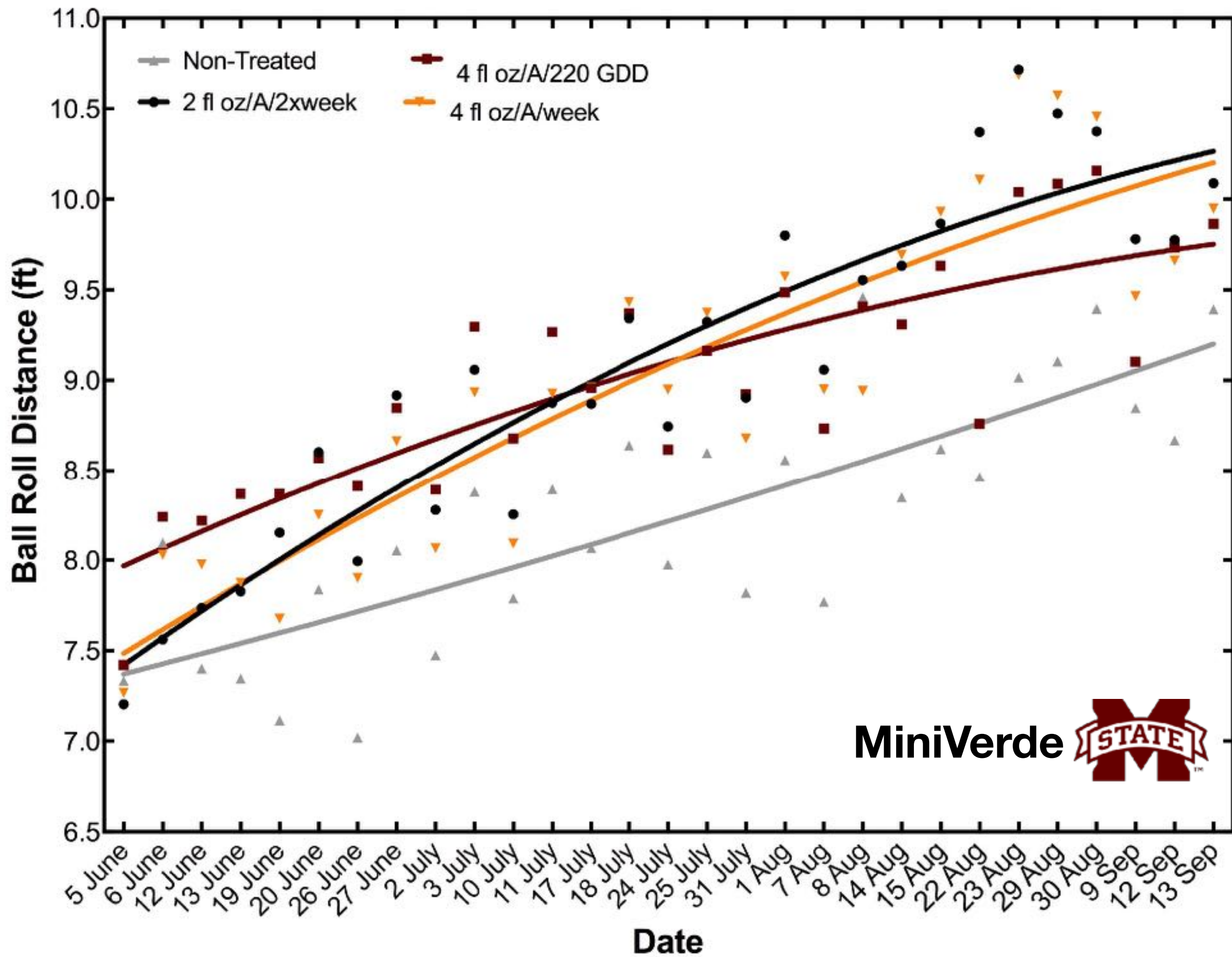




**TifEagle**

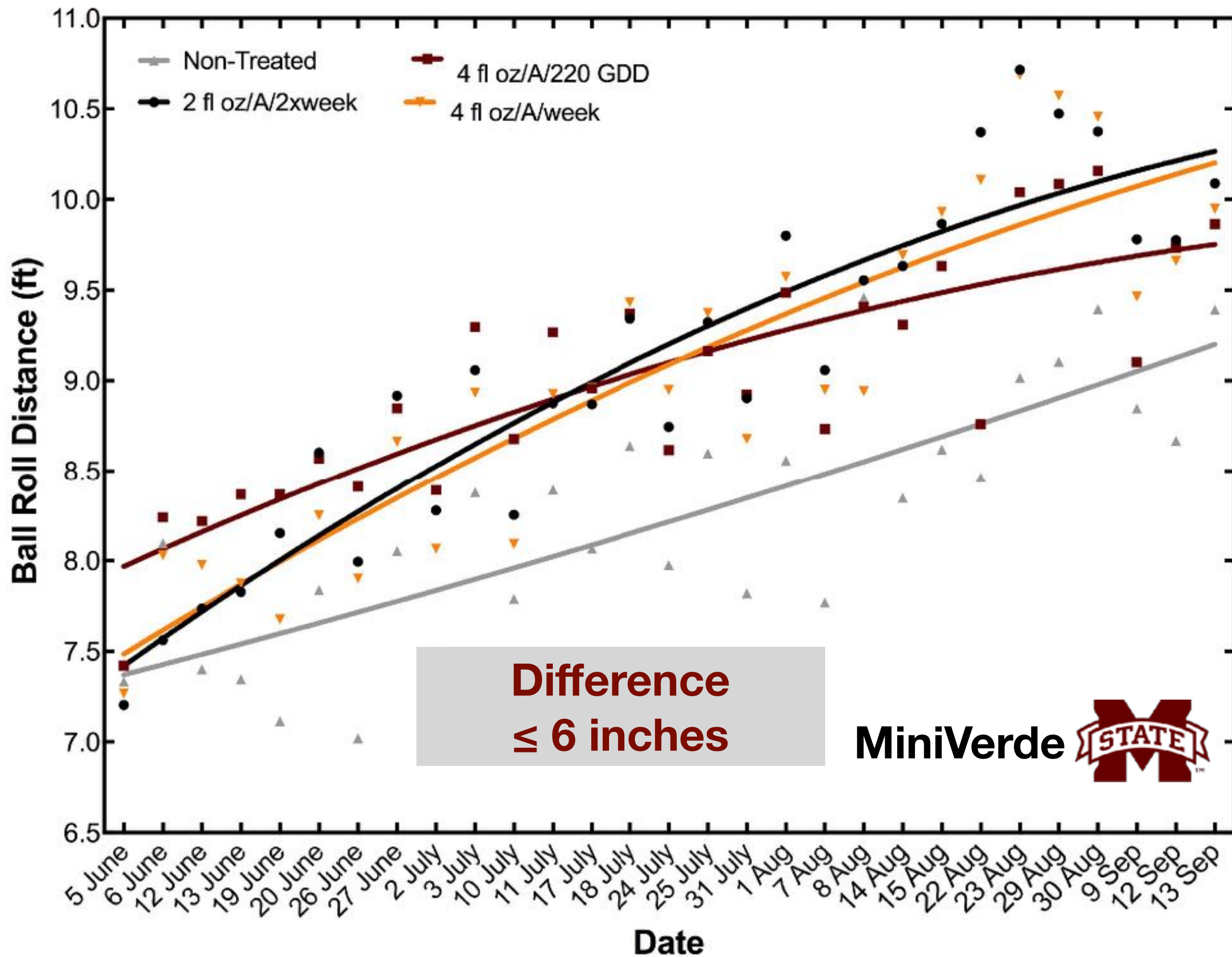






MiniVerde 







# Stress Meter

**Panic  
Attack!**

**Anxiety**

**Stressed**

**Coping**

**Relaxed**

**Detach**



# **What does it mean?**

- We know that over-regulation makes off-types more visible**
- GDD scheduling can prevent over-regulation, helping mask off-type problems**
- Primo and Anuew affect UDBG different → benefits to mixture, particularly on greens with off-types**
- Is the 6 inches of green speed worth it at your facility? (when golfers can't tell the difference)**





Primo Maxx at 4 fl oz  
(weekly)

Primo Maxx at 4 fl oz  
(Every 220 GDD)

***Pythium* spp. Outbreak  
in September 2018  
Knoxville, TN**

**Image: 28 Sept. 2018**





# Integrated Off-Type Management IOTM





# Conclusions

- **Starts with producer selection and never stops after grass in place**
- **Diligence at establishment is critical**
- **PGR applications best means of masking**
- **No need for weekly Primo applications at 3 fl oz/A (or higher)**
  - **Every application is reducing growth 49 to 62% (under best conditions) and complete recovery takes an extended period**



**NEVER STOP  
LEARNING**

---



**Consider GDD based PGR  
applications in 2019**





Tweets 2,132 Following 812 Followers 1,310 Likes 3,826 Lists 0 Moments 0

Edit profile

**Eric Reasor**  
@TurfBlade  
Assistant professor of turfgrass science at Mississippi State University | @MSUTurfSchool #MSturf | Turfgrass breeding and evaluation | UT Turf House Alumnus  
Starkville, MS  
pss.msstate.edu/students/gstm....  
Joined March 2014

Tweets Tweets & replies Media

You Retweeted

**Army WP Football** @ArmyWP\_Football · Nov 3  
The will to come together and execute.  
#GoArmy

A close-up, low-angle shot of a person's face, looking upwards, with a hand near their mouth.

**Your Tweet activity**  
Your Tweets earned 5,626 impressions over the last 28 days  
[View your top Tweets](#)

**Who to follow** · Refresh · View all  
Followed by James D. McCurdy and others  
**Matt Bertucci** @Bertucci...  
[Follow](#)

@TurfBlade      eric.reasor@msstate.edu



# Questions?

