SFMA SPORTS FIELD MANAGEMENT ASSOCIATION

# Turfgrass Irrigation: Water Quality, Quantity, and Lack of Thereof

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UF IFAS
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# Water Quality, Quantity, and Lack of Thereof

FOR THE
#GATORGOOD

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# Past Present Education/Employers



UNIVERSITY OF CALIFORNIA
UC RIVERSIDE
Turfgrass Science

UF | UNIVERSITY of FLORIDA

UF | IFAS Extension
UNIVERSITY of FLORIDA

# Strategies to Reduce (Potable) Irrigation Water Consumption for Turf

1. Deficit Irrigation
2. Sufficient N fertilization
3. Irrigation with recycled/impaired water
4. Use of surfactants
5. Increase irrigation efficiency
   - I. Scheduling
     - a) Climate data
     - b) Soil water status
   - II. Improve Water Distribution

# Water Use (Rate)

The total amount of water used by a turfgrass plant or sward through evaporation, transpiration, and for growth (per unit time). Because amount used for growth is small, it is usually referred to as evapotranspiration (ET) in inches or mm per day, week, or month.

# Relative Turfgrass Water Use (Huang, 2006)

| Relative Ranking | ET rate (mm/d) | Turfgrass Species |
|---|---|---|
| Very Low | <6 | Buffalograss |
| Low | 6-7 | Bermudagrass<br>Centipedegrass<br>Zoysiagrass |
| Moderate | 7-8.5 | Hard fescue<br>Chewing fescue<br>Creeping red fescue<br>Bahiagrass<br>Seashore paspalum<br>St. Augustinegrass |
| High | 8.5-10 | Perennial ryegrass<br>Kikuyugrass |
| Very high | >10 | Tall fescue<br>Creeping bentgrass<br>Annual bluegrass<br>Kentucky bluegrass<br>Rough bluegrass<br>Annual ryegrass |

# Deficit Irrigation

Irrigating turf with some fraction of water that is less than the estimated reference ET.

# Weather Station Networks

(www.cimis.water.ca.org)

(https://fawn.ifas.ufl.edu/)

$ET_o$ calculated from

- Solar radiation
- Temperature
- Humidity
- Wind speed

$$ET_o = \frac{0.408\Delta(R_n - G) + \gamma \frac{900}{T+273} u_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34u_2)}$$

# Crop Coefficients (Kc)

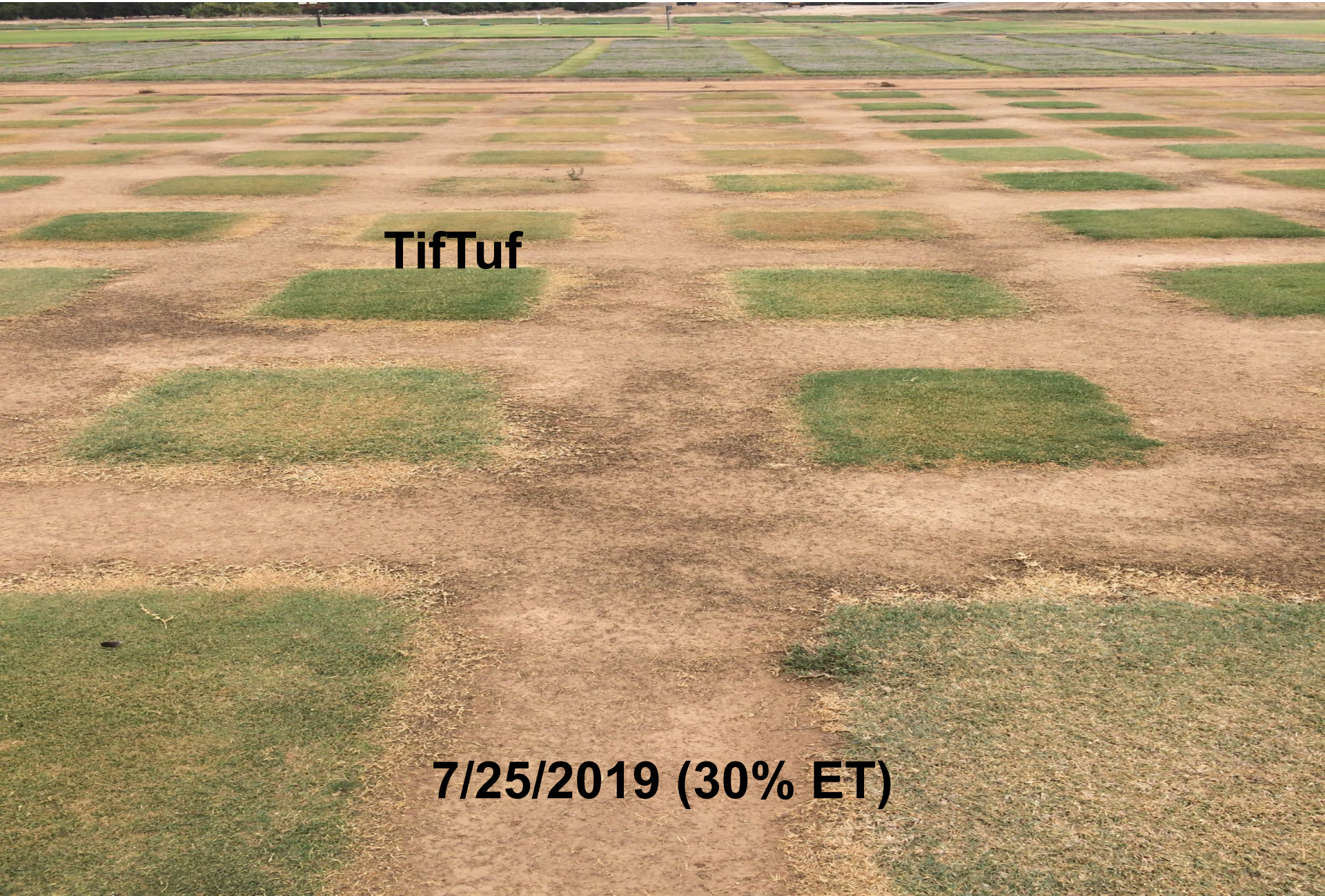
Table A.4. Monthly crop coefficients ($K_c$) for turfgrasses developed in Irvine, California and Tucson, Arizona .

| Month | Irvine $K_c$[z] | | Tucson $K_c$[y] |
|---|---|---|---|
| | Cool-season turfgrass | Warm-season turfgrass | Fairway quality bermudagrass overseeded in winter |
| January | 0.61 | 0.55 | 0.78 |
| February | 0.64 | 0.54 | 0.79 |
| March | 0.75 | 0.76 | 0.86 |
| April | 1.04 | 0.72 | 0.90 |
| May | 0.95 | 0.79 | 0.85 |
| June | 0.88 | 0.68 | 0.78 |
| July | 0.94 | 0.71 | 0.78 |
| August | 0.86 | 0.71 | 0.82 |
| September | 0.74 | 0.62 | 0.83 |
| October | 0.75 | 0.54 | – |
| November | 0.69 | 0.58 | 0.82 |
| December | 0.60 | 0.55 | 0.79 |

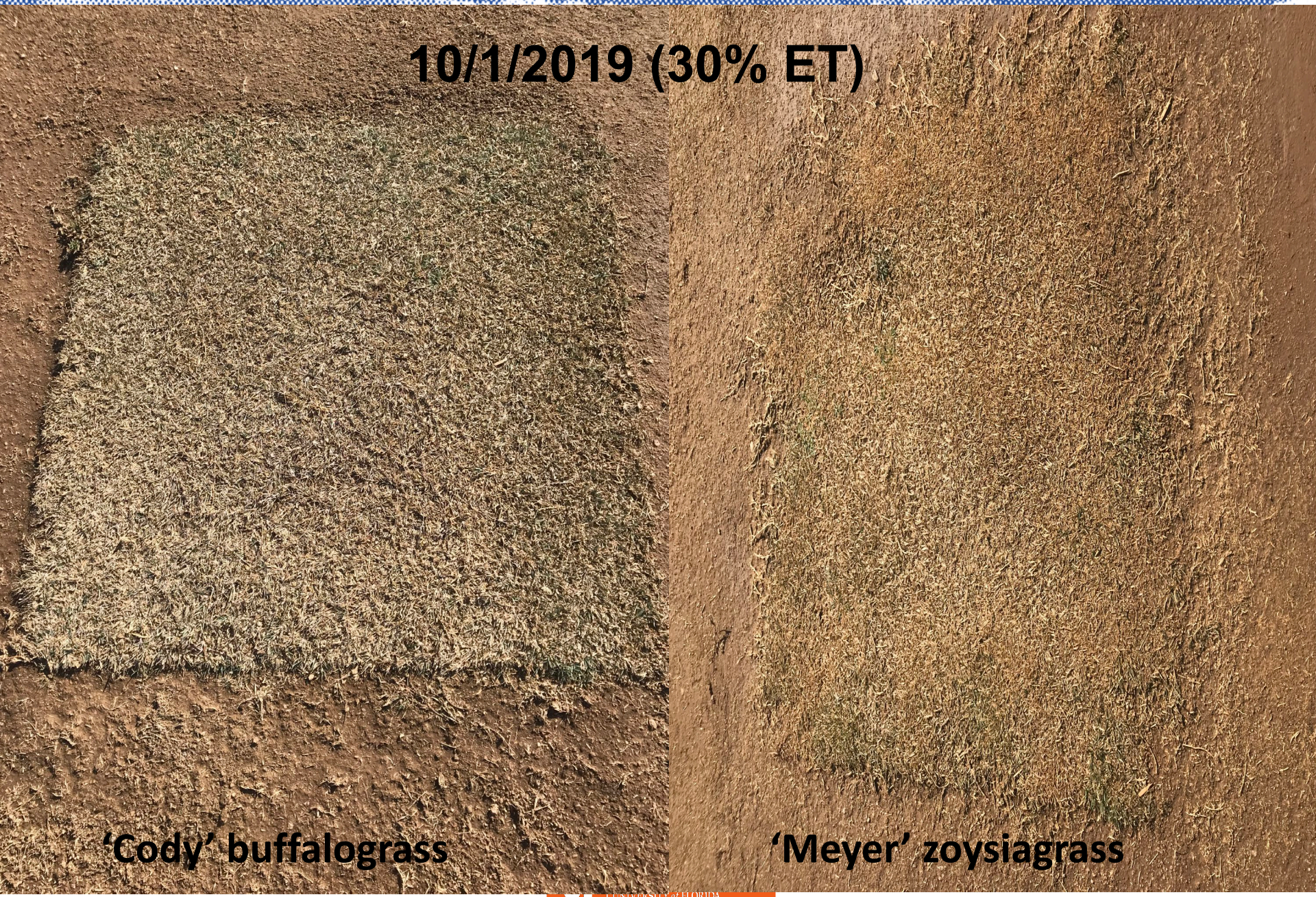
# 2016 NTEP/USGA Coeseason Drought Test

# 2018 NTEP/USGA Cool-season Drought Test

# 2018 NTEP/USGA Cool-season Drought Test



# 10/1/2019 (30% ET)



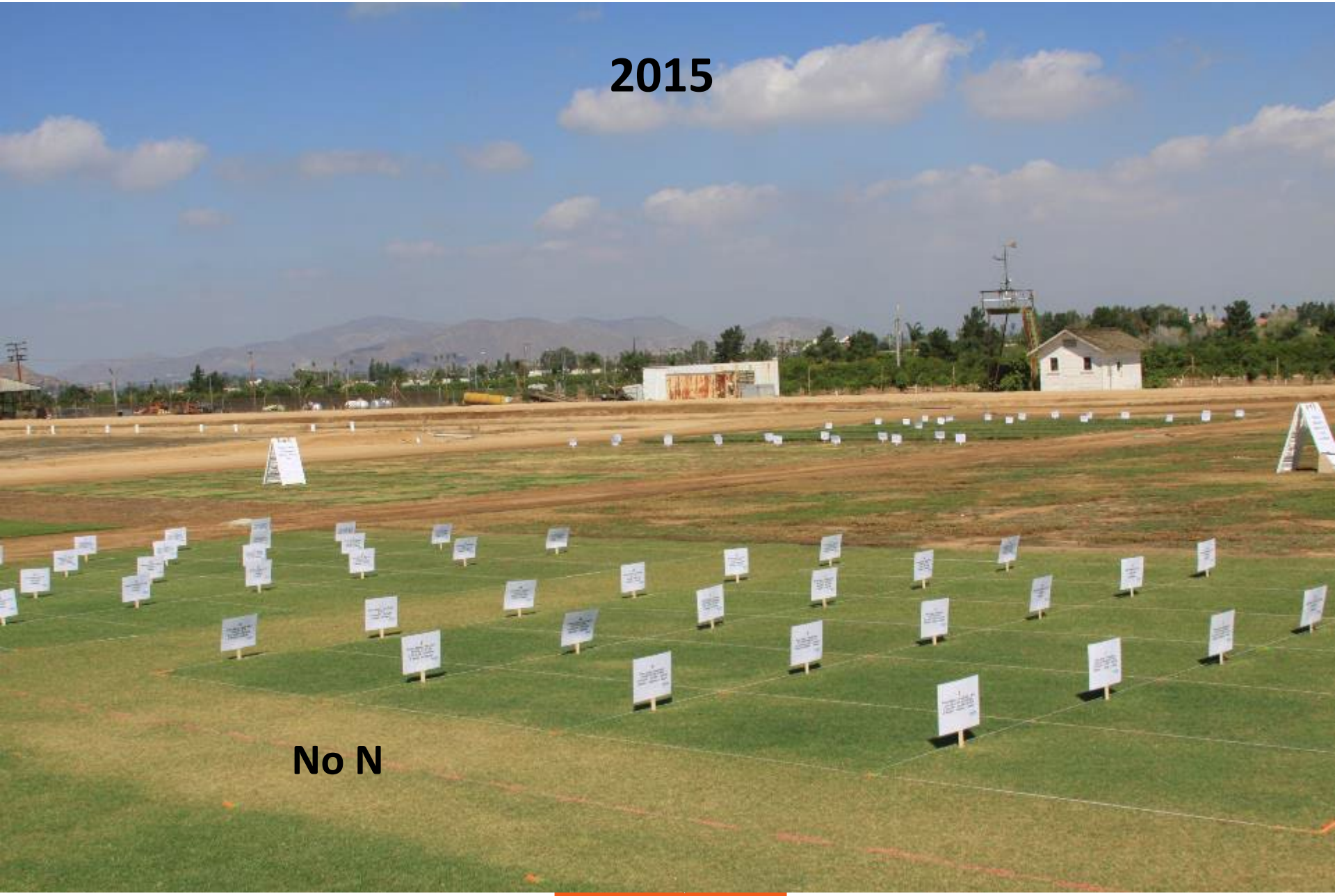
‘Cody’ buffalograss

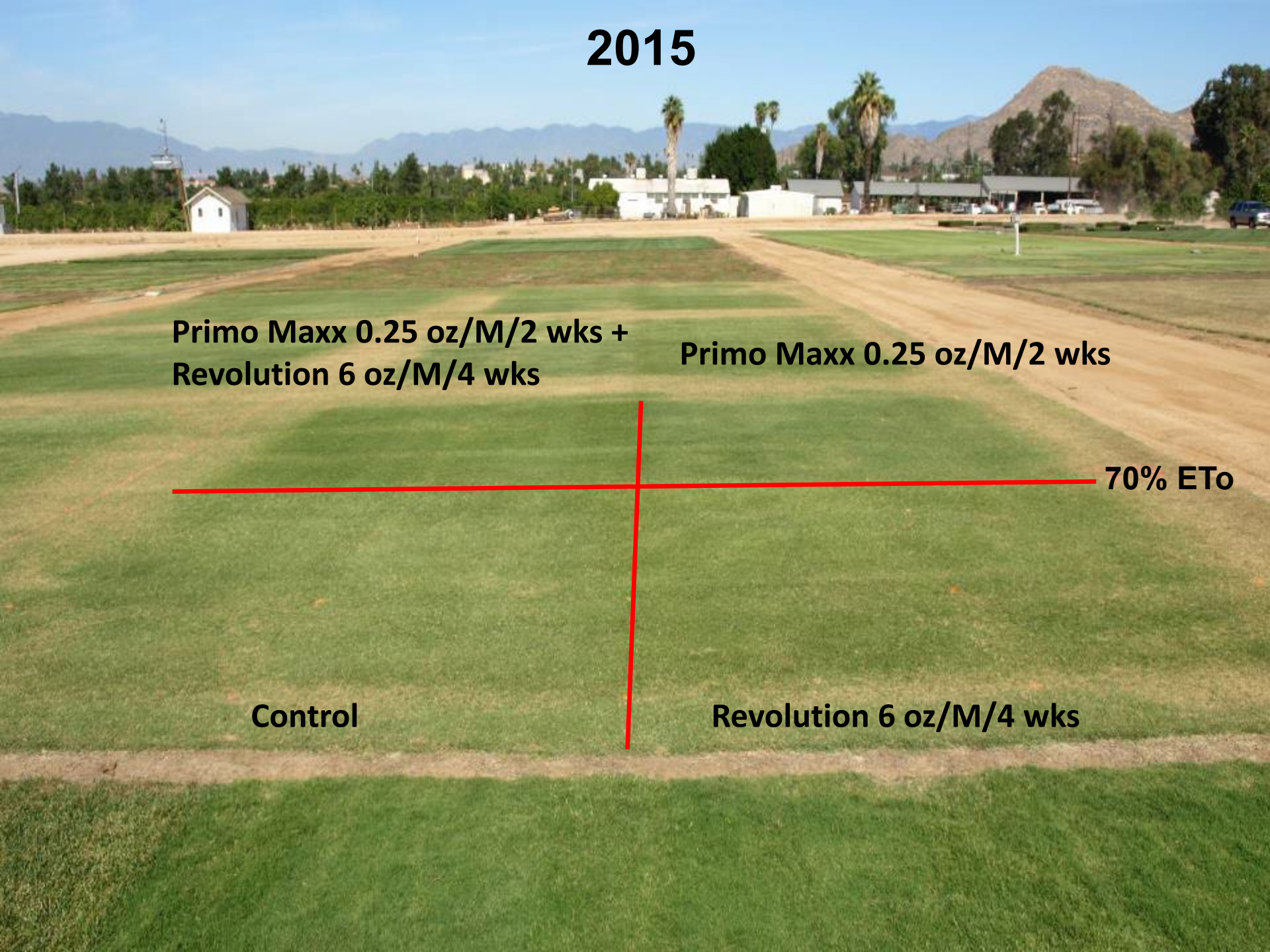
‘Meyer’ zoysiagrass

# Find a Study near you!

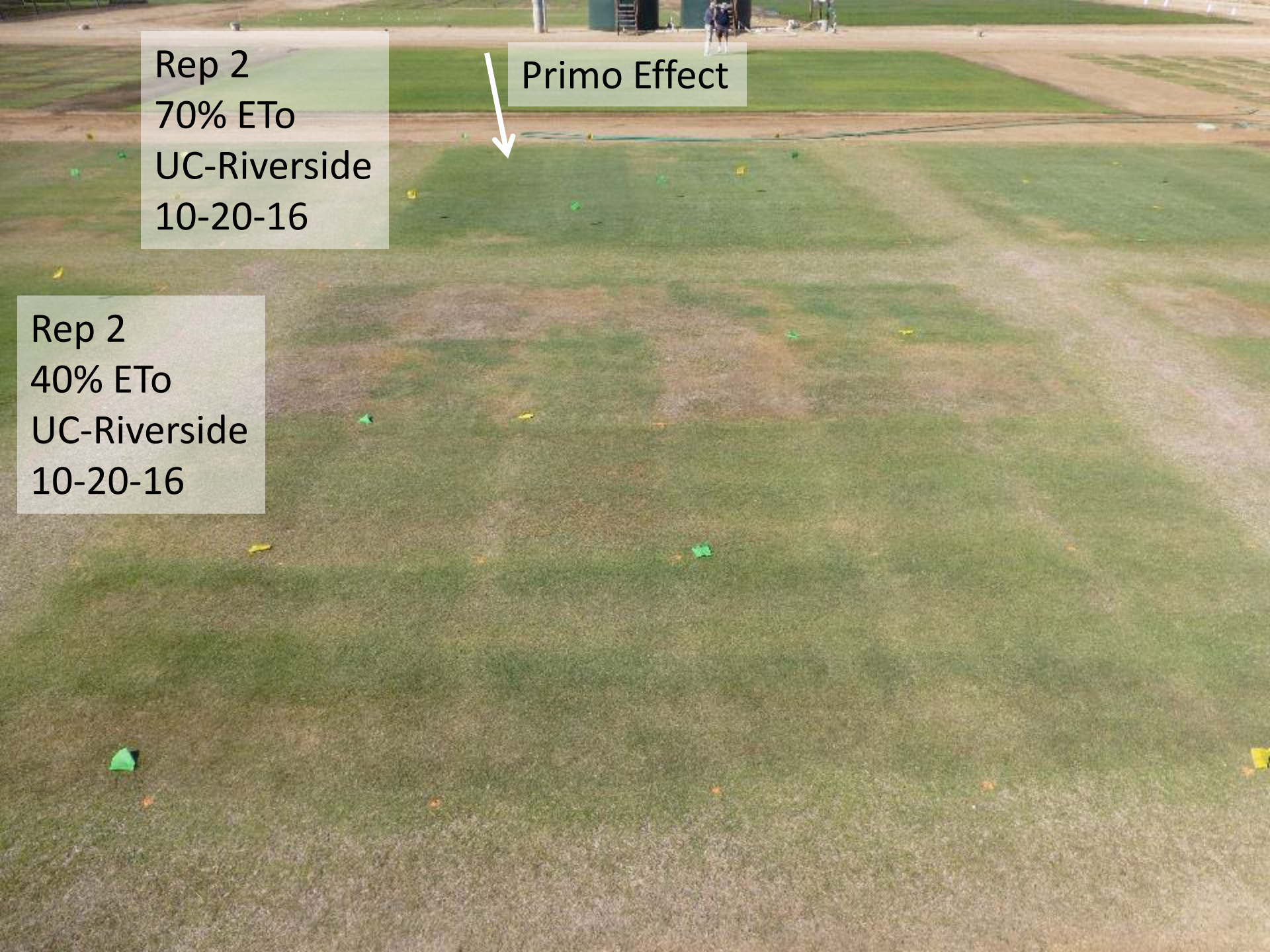

# Turfgrass Evaluation

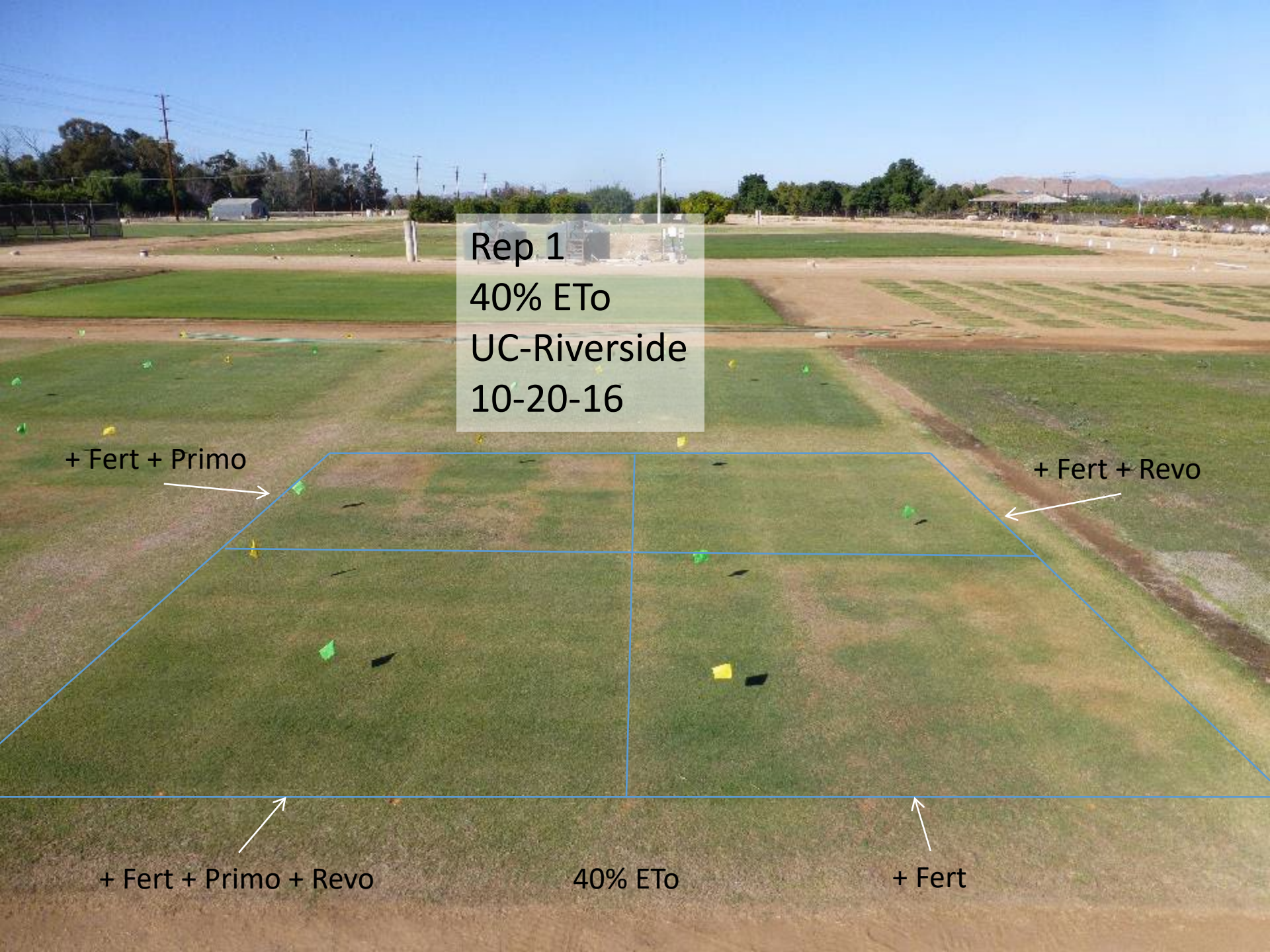


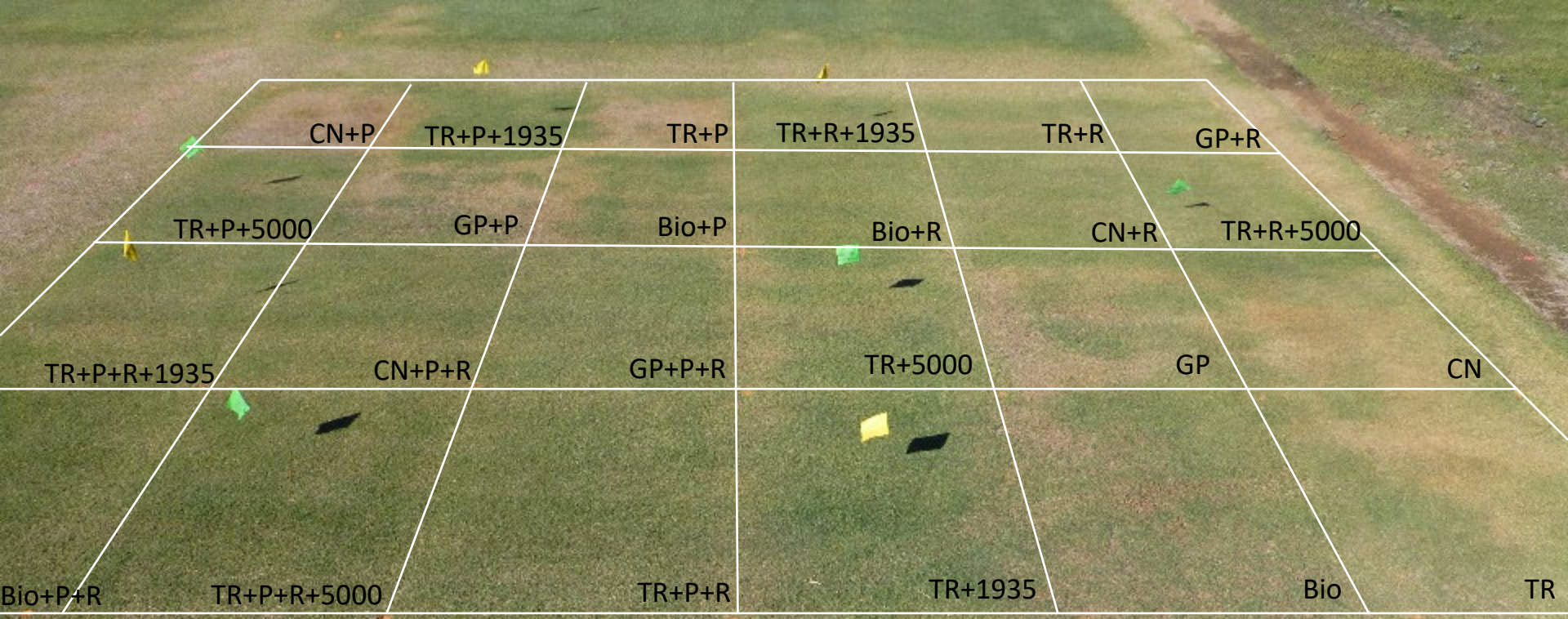

2015
No N


2015
Primo Maxx 0.25 oz/M/2 wks +
Revolution 6 oz/M/4 wks
Primo Maxx 0.25 oz/M/2 wks
70% ETo
Control
Revolution 6 oz/M/4 wks

# Can products help turf look better with less water?
# 2016-17


Rep 2
70% ETo
UC-Riverside
10-20-16
Primo Effect
Rep 2
40% ETo
UC-Riverside
10-20-16


Rep 1
40% ETo
UC-Riverside
10-20-16
+ Fert + Primo
+ Fert + Revo
+ Fert + Primo + Revo
40% ETo
+ Fert




Rep 1
40% ETo
UC-Riverside
10-20-16

P = Primo
R = Revolution
GP = GroPower
TR = Turf Royale
Bio = Ocean Organics Biostimulant Program
CN = Calcium nitrate
1935 = ACA1935 (patent pending)
5000 = ACA5000 (patent pending)


No Revolution
Revolution


“We know Revolution is good,
but we can’t afford it on fairways.”

# Let’s talk about the problem

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RESEARCH

## Penetrants vs. Retainers: Understanding Wetting Agent Claims and the Science Behind Them

June 02, 2023

By Daniel O’Brien, M.S., University of Arkansas
Mike Fidanza, Ph.D., Penn State University
Stan Kostka, Ph.D., Penn State University
Mike Richardson, Ph.D., University of Arkansas

Regardless of whether they’re called “penetrants” or “retainers,” wetting agents are an invaluable tool to help get water into the rootzone and keep it there.

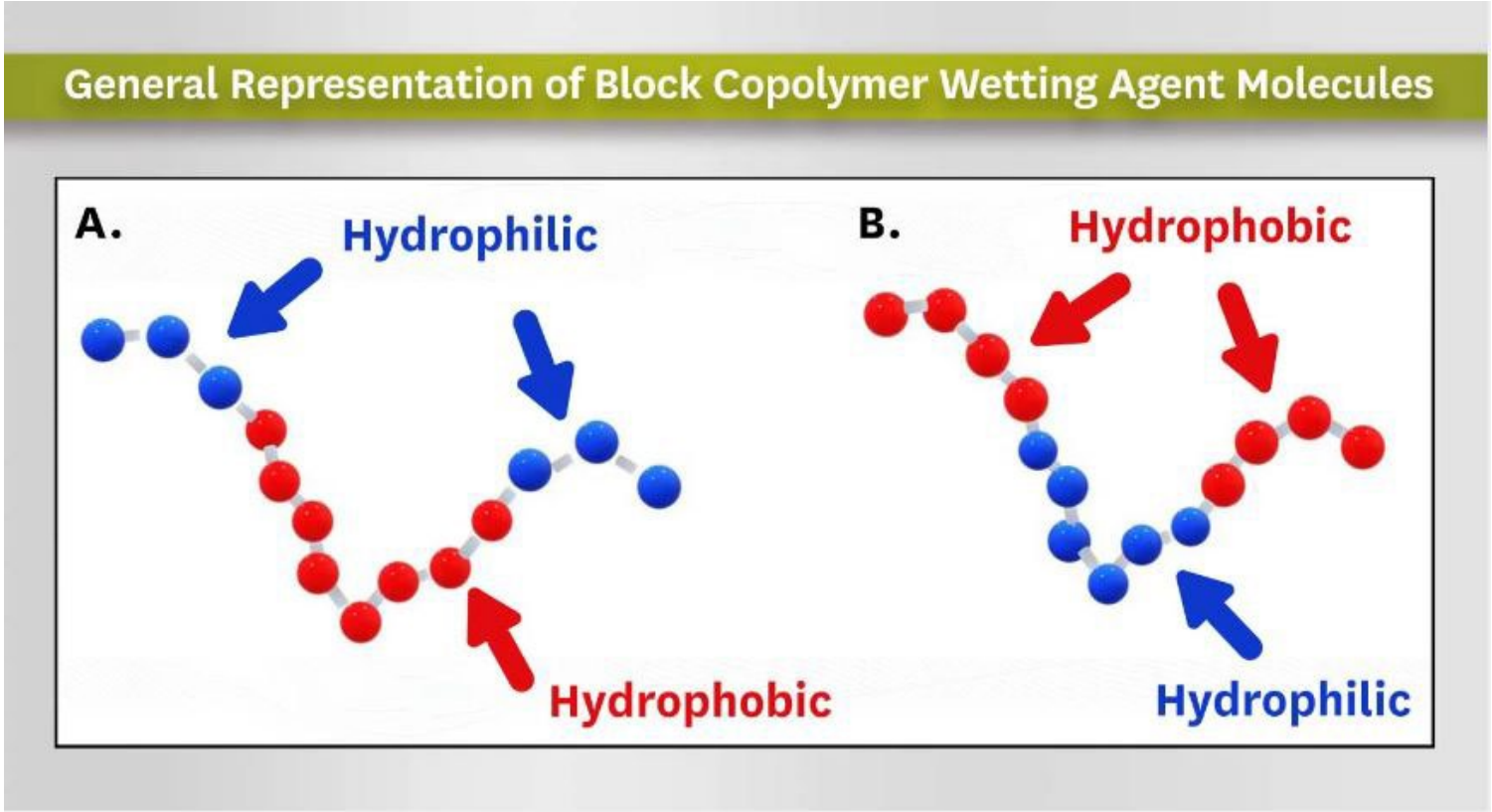
# Use of wetting agents

**Table 1.** Soil surfactant products for the turf industry in the USA market in 2019.

| Chemical Class | *n* | Chemical Category | *n* | Formulation Category | *n* |
|---|---|---|---|---|---|
| Nonionic | 142 | Block Copolymer | 112 | Block Copolymer | 94 |
| | | | | Block Copolymer - Alcohol Ethoxylate Blends | 3 |
| | | | | Block Copolymer + Alkylpolyglycoside | 5 |
| | | | | Block Copolymer - Maleic Acid Blends | 3 |
| | | | | Block Copolymer - Solvent Blends | 2 |
| | | | | Modified Methyl Capped Block Copolymer | 1 |
| | | | | Oleic Acid Esters of Block Copolymer | 1 |
| | | | | Other Block Copolymer Blends | 3 |
| | | Alcohol | 2 | Alcohol Ethoxylates | 2 |
| | | Alkylpolyglucoside | 4 | Alkylpolyglucoside | 4 |
| | | Botanical | 1 | Yucca plant extract | 1 |
| | | Organosilicone | 1 | Organosilicone | 1 |
| | | Polyalkylene | 5 | Hexahydroxy Polyalkylene Polymers | 1 |
| | | | | Octahydroxy Polyalkylene Polymers | 4 |
| | | Polyoxyethylene | 17 | Polyoxyethylene - Alkylpolyglucoside Blends | 2 |
| | | | | Polyoxyethylene - Block Copolymer Blends | 2 |
| | | | | Polysorbate Polyoxyethylene Copolymer | 13 |
| Anioic | 18 | Anioic and Blends with Anionics | 18 | Anionic Blends | 11 |
| | | | | Blends of Anionic and Nonionic | 7 |
| Unknown | 32 | Not Disclosed | 32 | Not Disclosed | 32 |
| | | | | *Total Products in the Marketplace:* | 192 |

(Fidanza et al., 2020)

# Penetrants vs Retainers




A. Penetrant

B. Retainer

(O'Brien et al., 2023)

# Wetting Agents (2018-19)

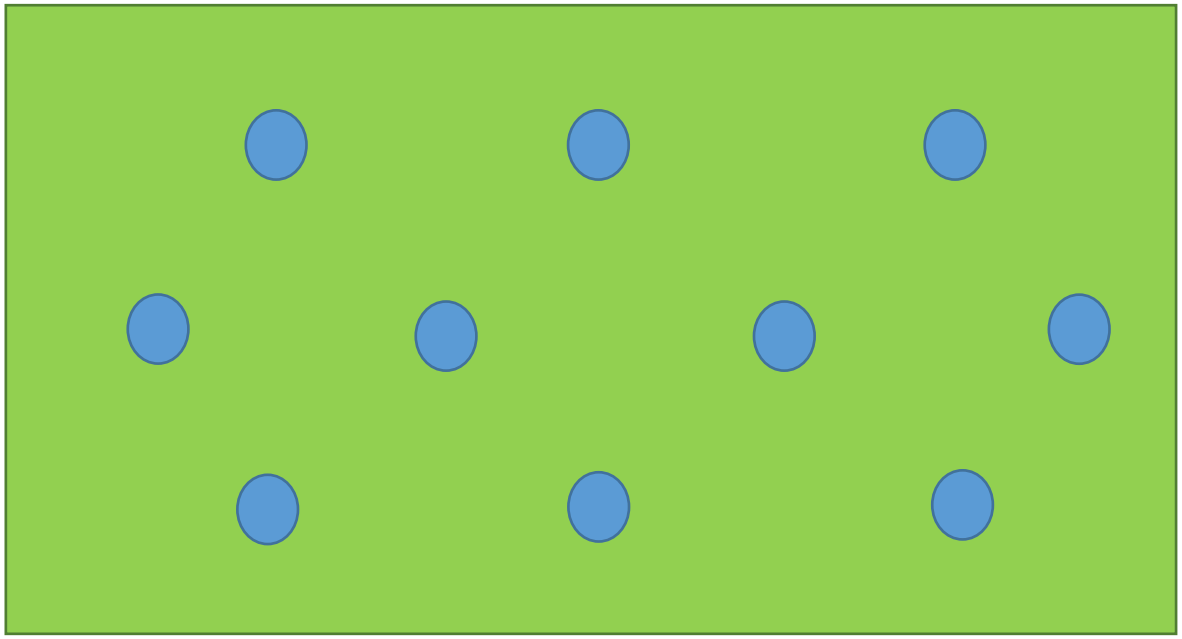
| Plot | Treatment | Rate | Company |
|---|---|---|---|
| Whole Plot | $ET_{os}$ Replacement | 45%-55%-65% | -- |
| Split Plot | Untreated control | -- | -- |
| Split Plot | Revolution | 6 oz/M | Aquatrols |
| Split Plot | ACA001 | 4 oz/M | Aquatrols |
| Split Plot | Tricure AD | 6 oz/M | Mitchell Products |
| Split Plot | MPX-5 | 3 oz/M | Mitchell Products |
| Split Plot | Forte + CounterAct Retain | 0.37 oz/M + 3 oz/M | Simplot |
| Split Plot | Forte + Brilliance | 0.37 oz/M + 3 oz/M | Simplot |
| Split Plot | Aquimax Turf Lateral | 8 oz/M (initial)/ 4 oz/M (subsequent) | Exacto |
| Split Plot | Passage | 6 oz/M | Numerator Tech |
| Split Plot | Vivax | 5 oz/M | Precision Laboratories |
| Split Plot | Cascade Plus | 8 oz/M (initial)/ 4 oz/M (subsequent) | Precision Laboratories |
| Split Plot | Hydro90+Symphony | 3 oz/M + 3 oz/M | Harrell's |

# Wetting Agent Trial

'Tifway II' (established 2017)
Mowing height: 1.27 cm
5 g N $m^{-2}$ $month^{-1}$
May- October

Visual Quality
NDVI
DIA
VWC
Soil moisture variability

# Fun with numbers!



μ = mean (VWC %)

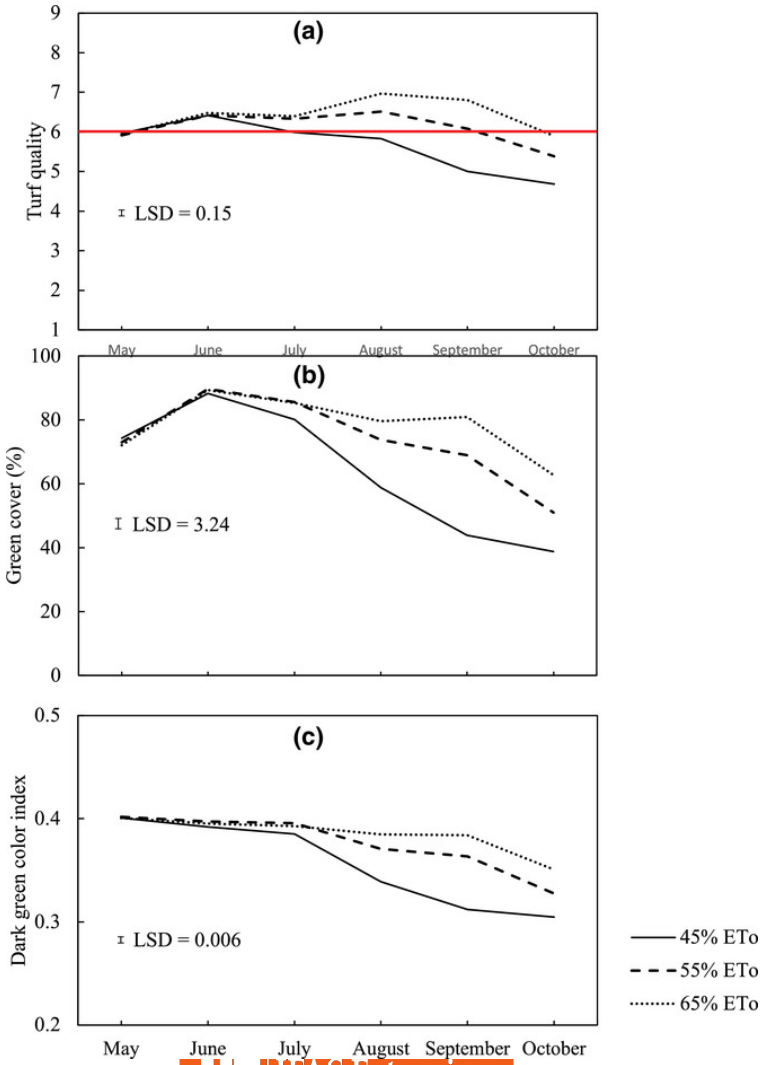
σ = standard deviation (uniformity of water distribution

# Results

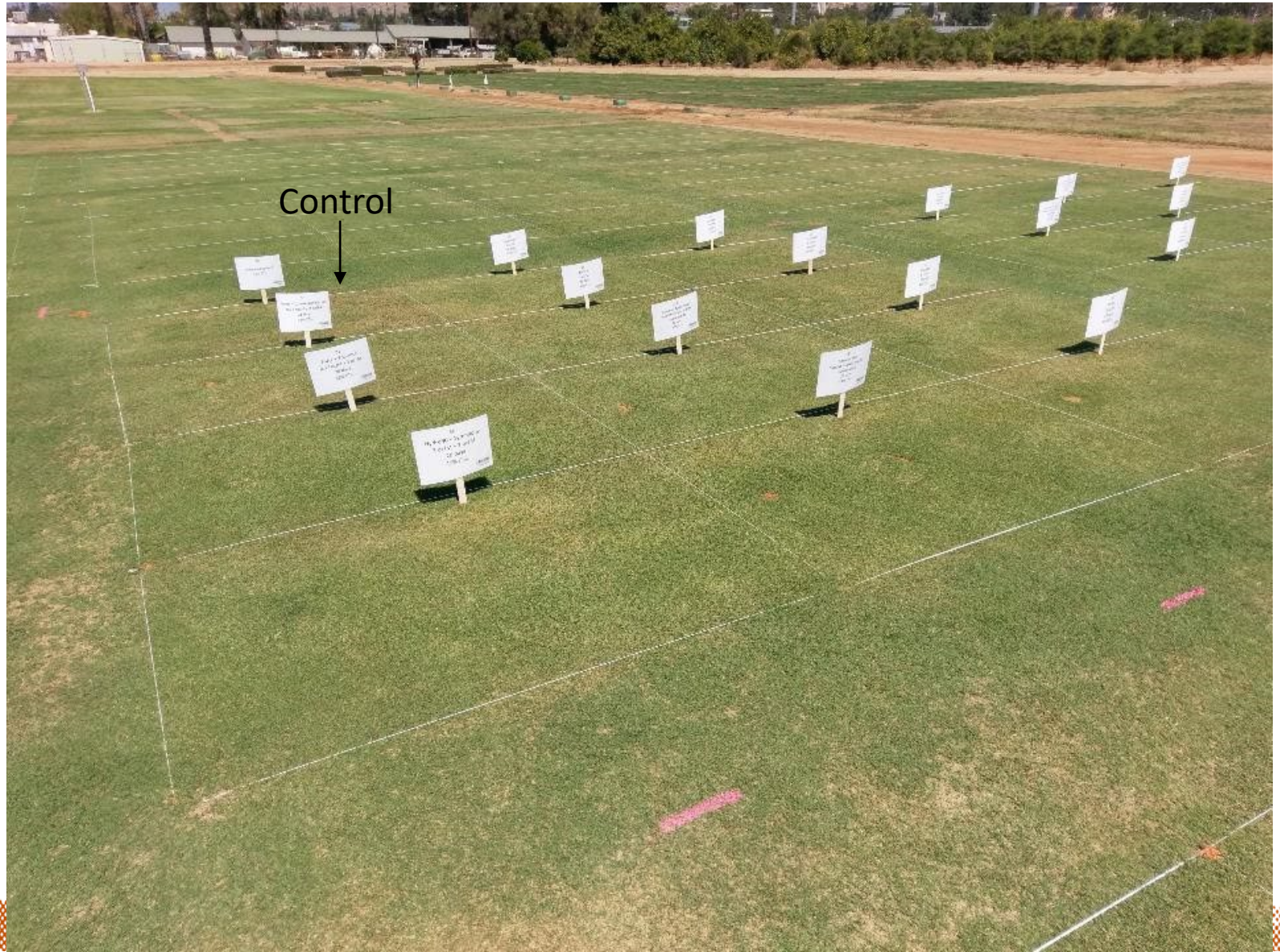
| Treatment | Turf quality | PGC (%) | DGCI | VWC (%, $m^3\ m^{-3}$) | Soil moisture variability† (2019) |
|---|---|---|---|---|---|
| Untreated control | 5.5 b | 65.8 c | 0.363 d | 16.1 c | 4.8 a |
| Revolution® | 6.1 a | 73.4 a | 0.374 ab | 18.4 a | 3.5 c |
| TriCure AD® (1x rate) | 6.1 a | 73.0 a | 0.374 ab | 17.7 ab | 3.7 bc |
| TriCure AD® (1/2 x rate) | 6.0 a | 71.8 ab | 0.372 abc | 17.5 b | 3.8 bc |
| Forté™ + CounterAct® Retain | 6.0 a | 69.7 b | 0.368 cd | 16.5 c | 3.9 bc |
| Forté™ + Brilliance® | 6.1 a | 73.5 a | 0.375 ab | 17.9 ab | 4.1 b |
| Aquimax® Turf Lateral | 6.1 a | 71.8 ab | 0.370 bc | 17.1 bc | 3.5 c |
| Passage | 6.2 a | 73.4 a | 0.376 a | 18.6 a | 3.6 c |
| Vivax™ | 6.1 a | 72.0 ab | 0.371 abc | 17.5 b | 3.7 bc |
| Cascade Plus™ | 6.1 a | 73.2 a | 0.372 abc | 17.7 b | 3.7 bc |
| Hydro-90® + Symphony® | 6.1 a | 73.1 a | 0.375 ab | 18.0 ab | 3.8 bc |

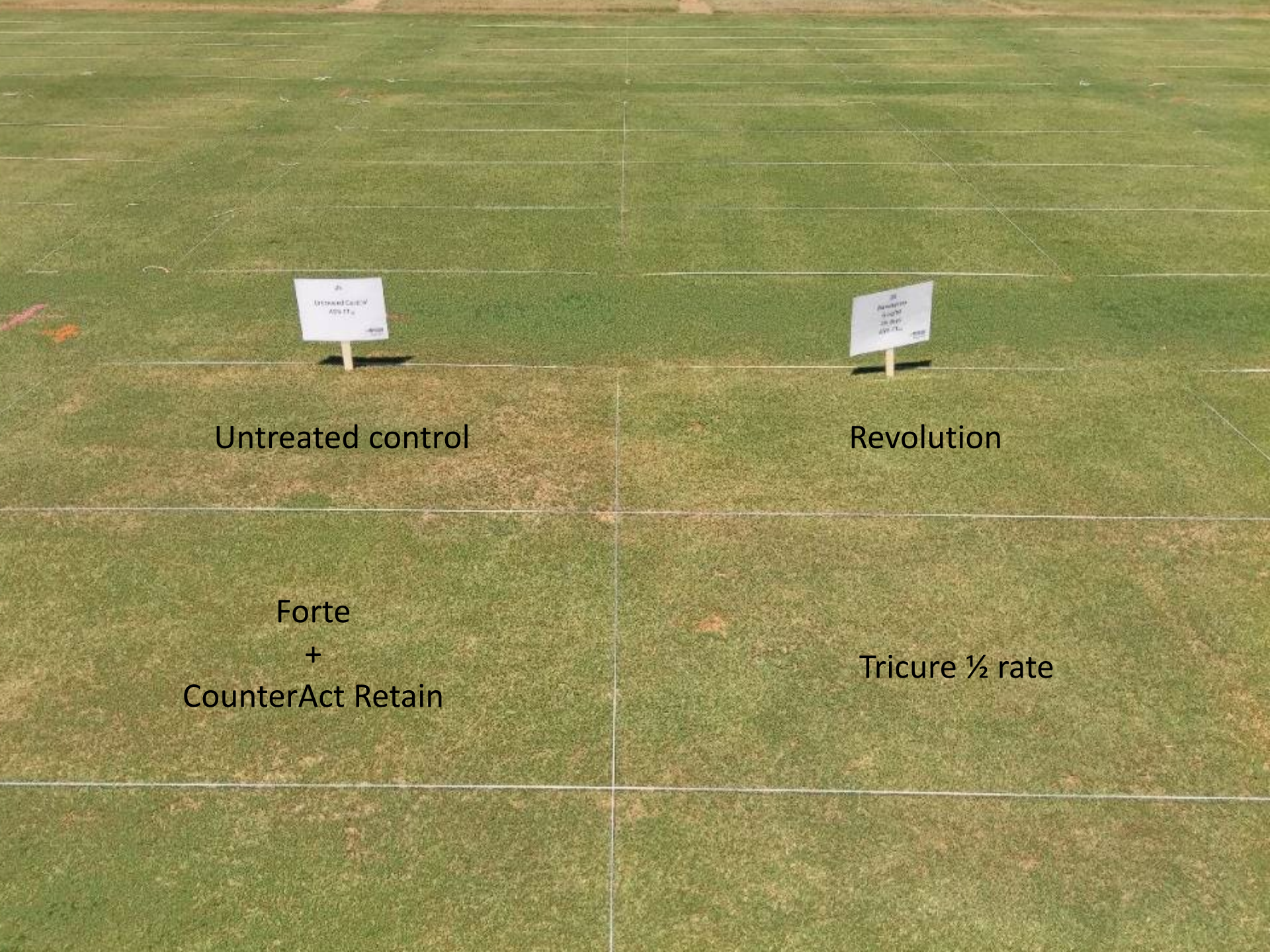
† Soil moisture variability was determined by calculating the standard deviation of VWC among 10 data points within each plot. The higher the standard deviation refers to higher variability, therefore, lower uniformity.
‡ Values followed by the same letter in a column are not significantly different from one another, according to Fisher's protected LSD, $P = 0.05$.

# Results


(a)
Turf quality
LSD = 0.15
(b)
Green cover (%)
LSD = 3.24
(c)
Dark green color index
LSD = 0.006
May
June
July
August
September
October
45% ETo
55% ETo
65% ETo

# Results




Untreated control
Revolution
Forte
+
CounterAct Retain
Tricure ½ rate

# Arkansas trial

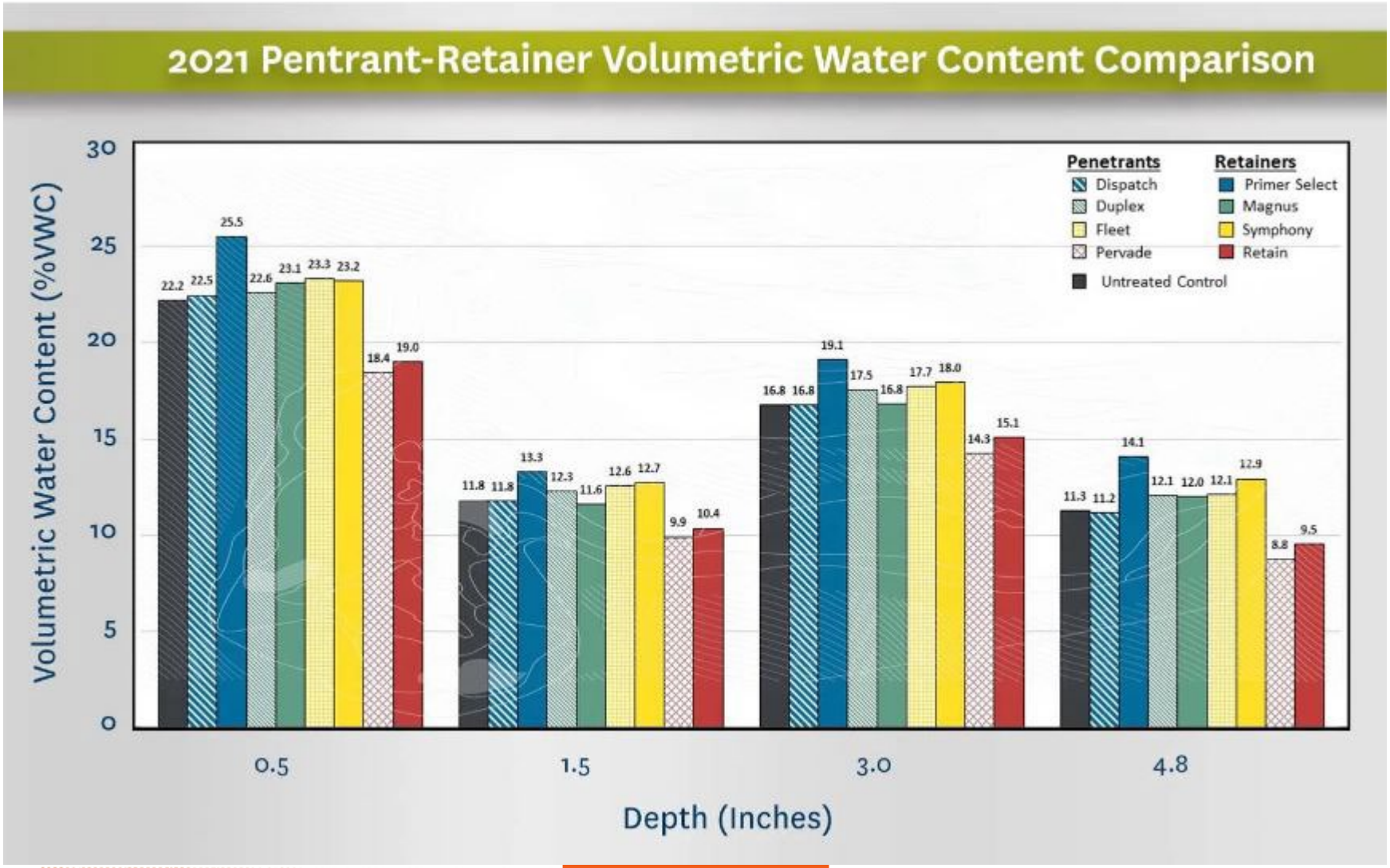
## Wetting Agent Products Tested in 2019 and 2021 Field Studies

| Manufacturer | Penetrant [1] | Retainer [2] |
|---|---|---|
| Aquatrols (Paulsboro, NJ) | Dispatch | Primer Select |
| Precision Labs (Waukegan, IL) | Duplex | Magnus |
| Floratine (Collierville, TN) | Pervade | Retain |
| Harrell's (Lakeland, FL) | Fleet | Symphony |

**1** Products marketed by the manufacturer to improve water "infiltration" and/or "penetration"

**2** Products marketed by the manufacturer to improve water "retention", "availability", and/or "hydration" for turfgrass rootzones

# Arkansas trial



# Conclusions (wetting agents)

Most wetting agents tested in this 2-yr study indicated positive effects on improving turf quality, PGC, DGCI, soil moisture, and soil moisture uniformity.

Our research suggested that turfgrass managers, especially those managing turfgrass on a fine sandy loam, can select the use of products according to their available budget.

# Conclusions (wetting agents)

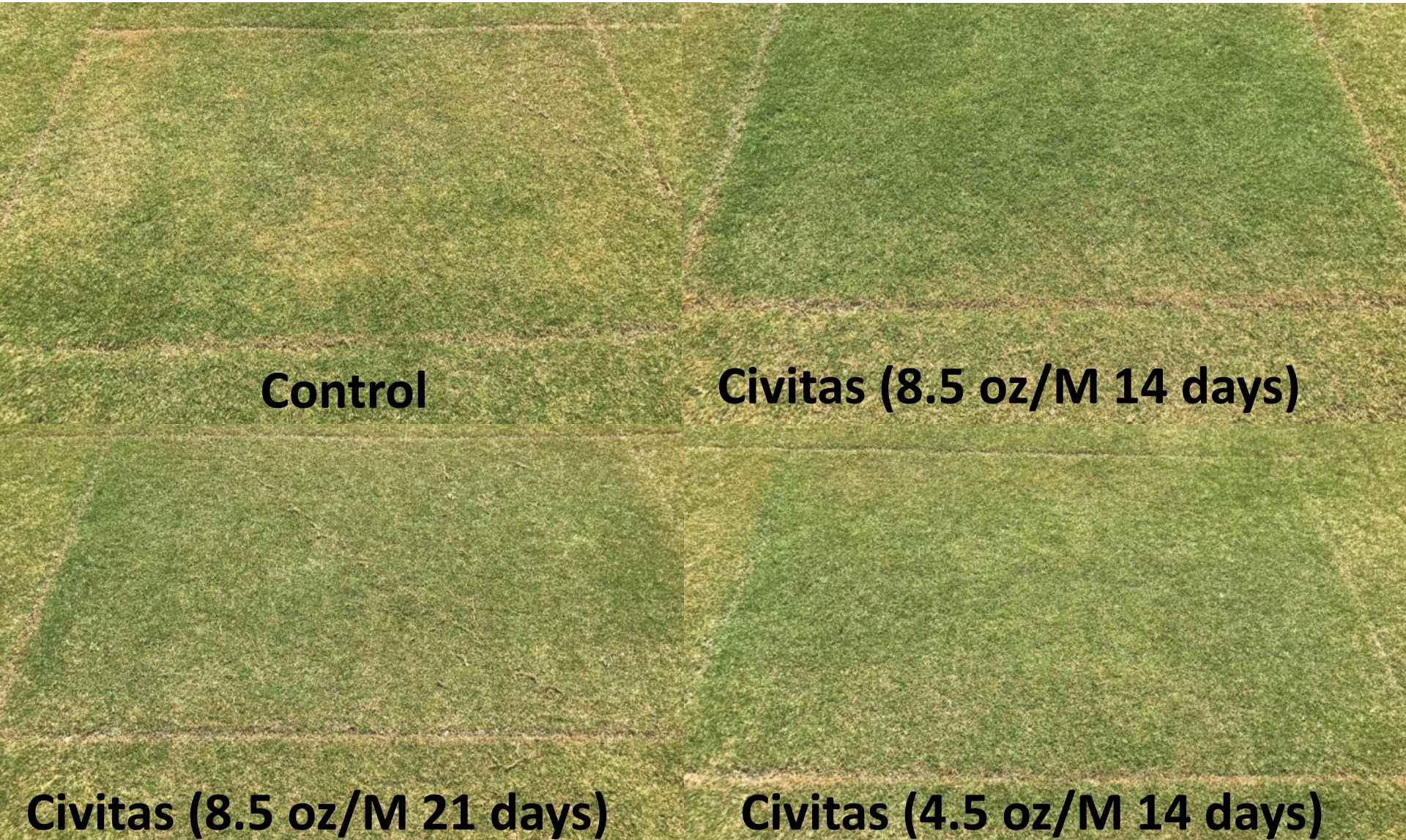
How much a wetting agent improves infiltration, retention and uniformity of rootzone moisture, regardless of any penetrant or retainer designation, is what's most important

Wetting agent function cannot be understood exclusively in terms of chemistry

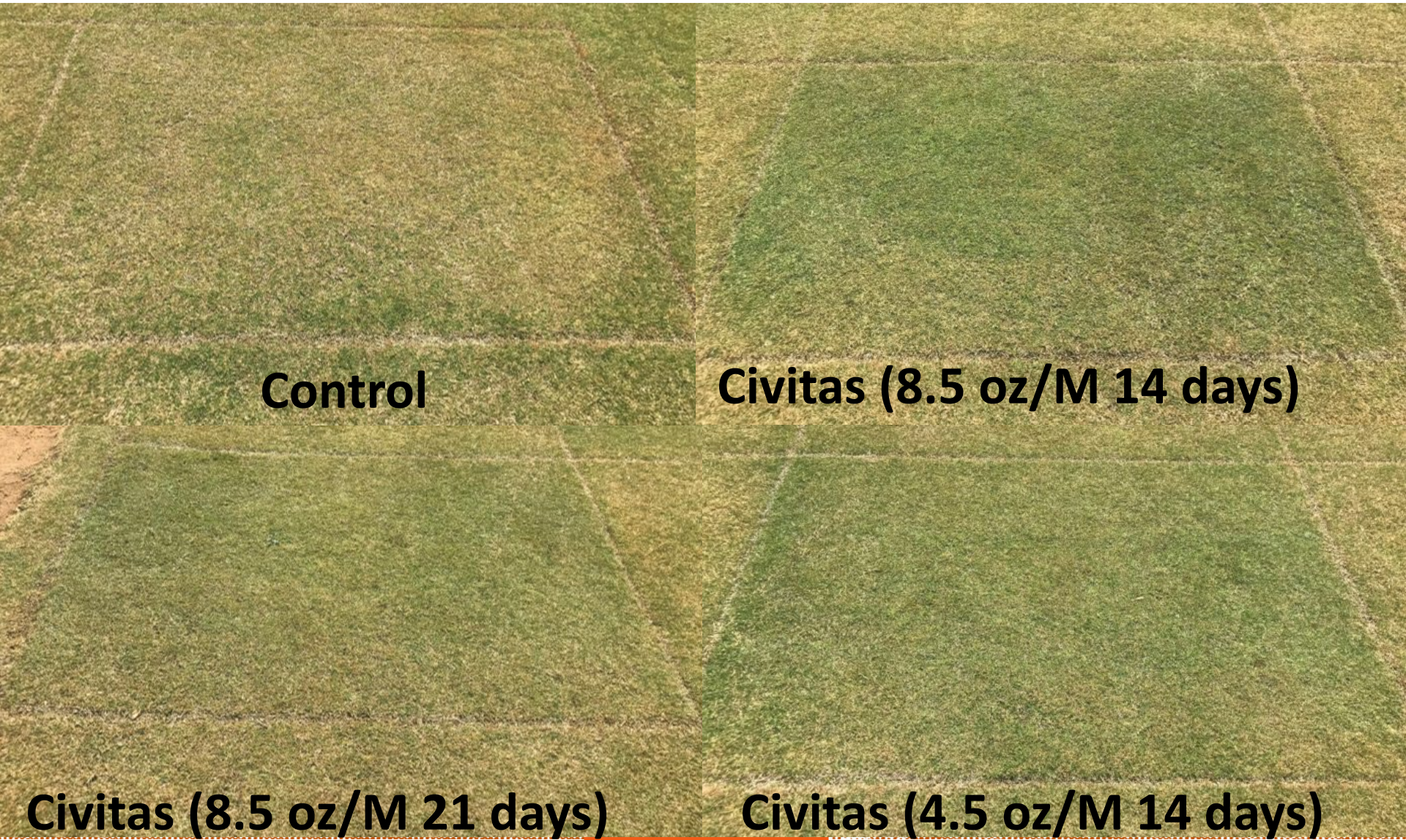
Data on heavy soils still lacking

# Civitas trial (2018)
# Bermudagrass & seashore paspalum
# 70% ETos vs 50% ETos


# Civitas trial (55% ET; 2019)



# Civitas trial (45% ET; 2019)



# Salinity issues in turfgrass

- What causes salinity problems?
  - Salinity in the water
  - Salinity in the soil
  - Testing for salinity
- Methods for managing salt
- Moisture/salinity sensors

# Three main problems relater do water quality

1. Salinity
2. Sodicity
3. Carbonates and bicarbonates

# Water Quality Parameters - Salinity

**Salinity – all irrigation water contains dissolved mineral salts and chemicals.**

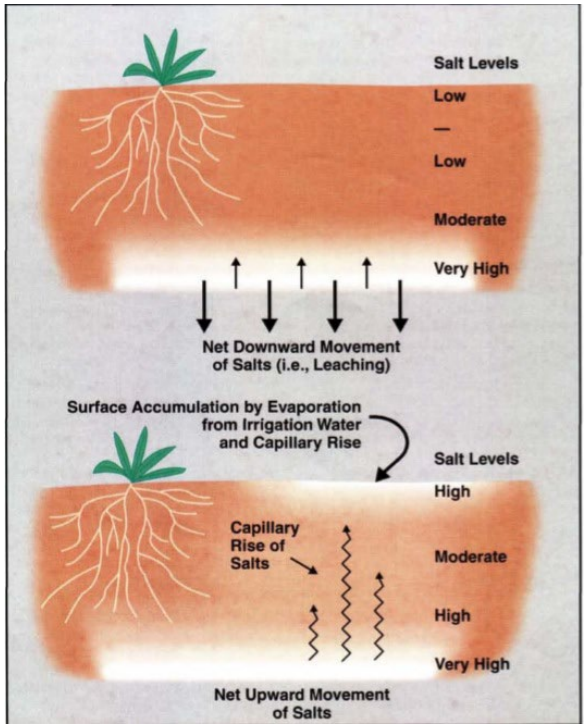
Direct and indirect injury:

Direct – injury to foliage from direct application of "salty" water.

Indirect – salts (sodium) causes clay soils to disperse and "plug" soil pores.

Indirect – salts accumulate at the soil surface as water evaporates leading to soil structure loss.

# Salinity




Good leaching conditions

Insufficient water with high ET

Carrow, Huck and Duncan, 2000

# Irrigation Audit

UF | IFAS Extension
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# Water Quality Parameters - Sodicity

**Sodicity – Concentration of Na to Ca and Mg.**

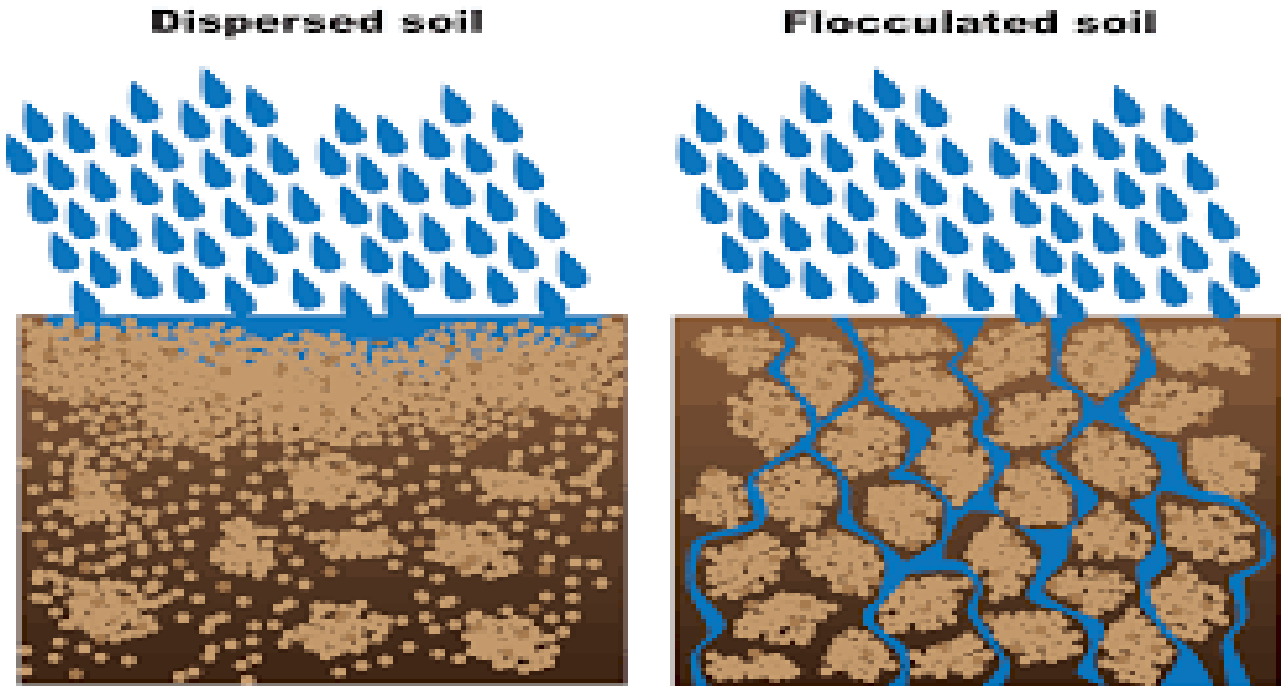
Both Ca and Mg (primarily Ca) are responsible for soil structure.

When excessive Na is applied to the soil, it displaces Ca from soil colloid causing soil deflocculation, and consequent permeability problems.

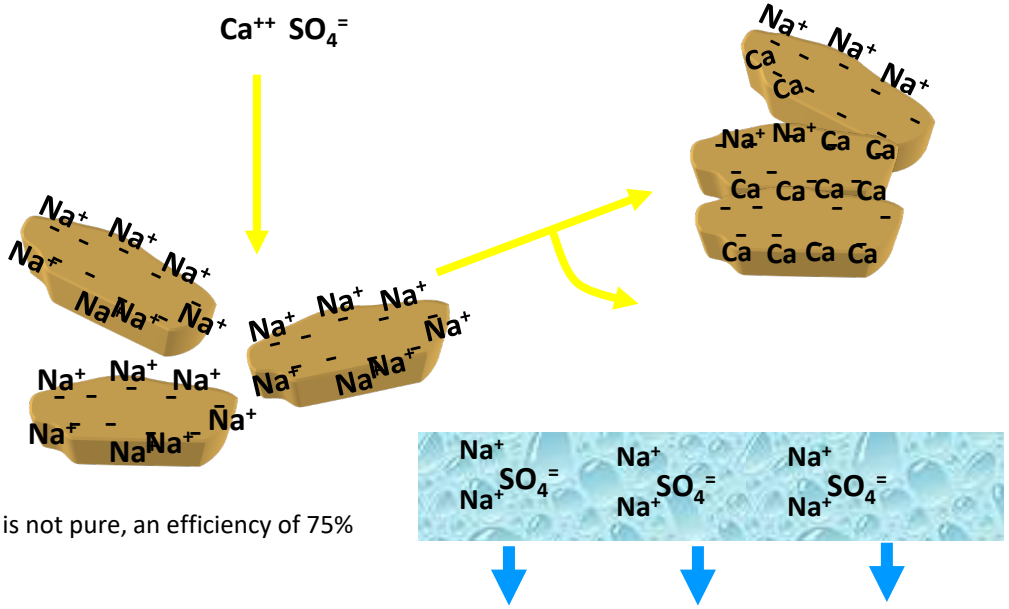
$$SAR = \frac{[Na^+]}{\sqrt{\frac{Ca^{2+} + Mg^{2+}}{2}}}$$

$SAR_{adj}$= SAR * [1+(8.4-pHc)]

# Sodic and Saline-Sodic Soils



# Managing Sodic Soils




Because gypsum is not pure, an efficiency of 75% is usually used.

# Plant Nutrition

•Additional N-P-K (and micronutrients) applied foliar

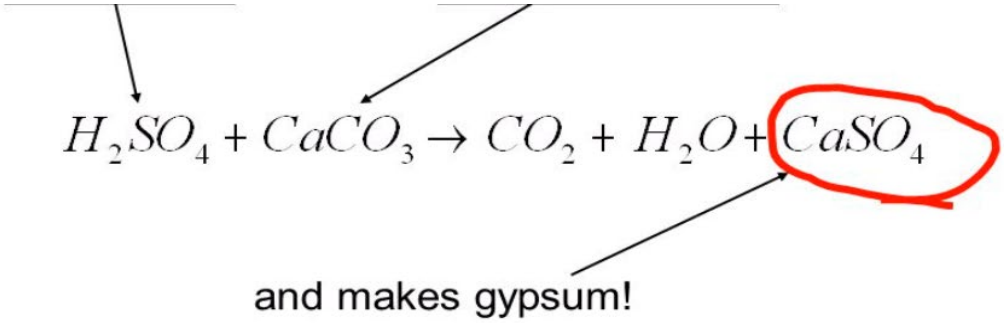
# Water Quality Parameters – Bicarbonates and Carbonates

## Bicarbonate and Carbonate

When irrigation water is high in bicarbonates ($HCO_3^-$) and carbonates ($CO_3^{-2}$), these ions readily react with any $Ca^{+2}$ and $Mg^{+2}$ in the water to form $CaCO_3$ and $MgCO_3$ (lime) which have low solubility. This leaves Na+ to dominate.

If the irrigation water is low $Ca^{+2}$ and $Mg^{+2}$, soil $HCO_3^-$ and $CO_3^{-2}$ levels increase, and Ca and Mg are then precipitated out as carbonates in the soil.

# Acidification




*Sulfuric acid is extremely dangerous and should only be handled by trained personnel.

Acidify when

Adj. $SAR_w$ > 6 , $HCO_3$ and $CO_3$ > 120 ppm, RSC > 1.25

# Turfgrass Water Conservation Strategies

- Warm-Season Turf
- Source of N
- Reclaimed Water
- Primo Maxx
- Wetting Agent
- Colorants
- Others?

# Acknowledgments