Professorship Turfgrass Ecology

University of Wageningen – August 31 and September 1, 2016

Trial lecture – Research and Teaching in Turfgrass Ecology

Bernd Leinauer

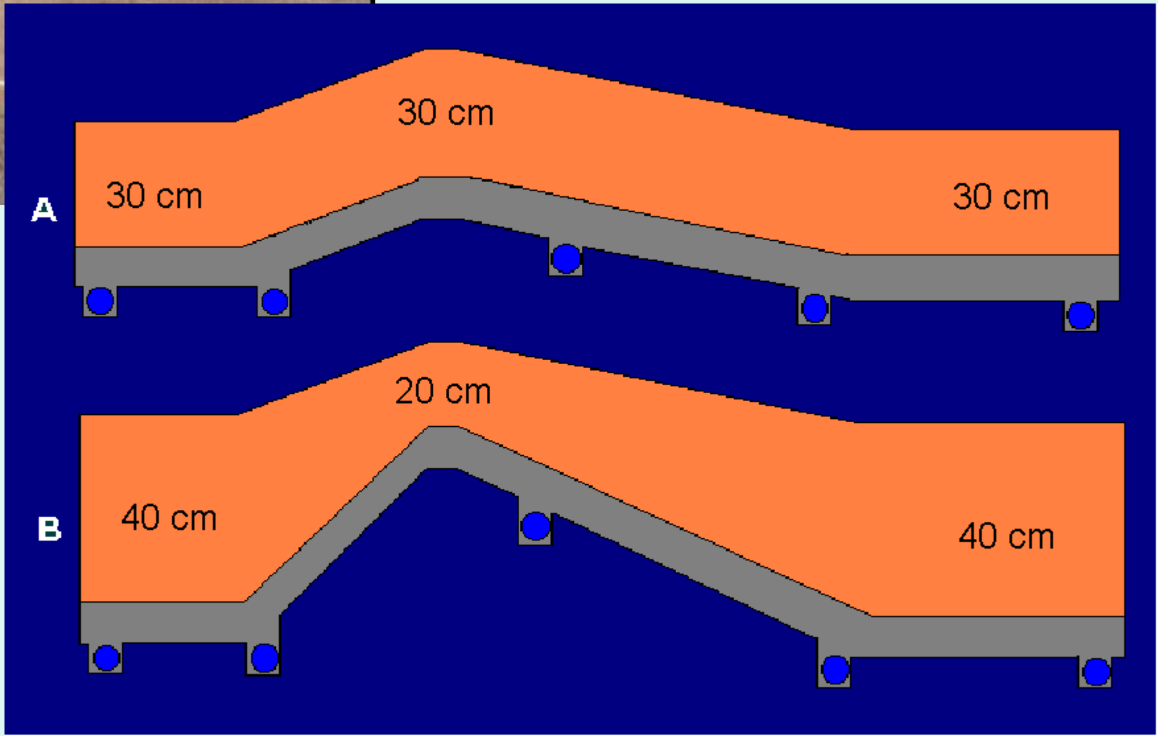
Professor & Extension Turfgrass Specialist

New Mexico State University

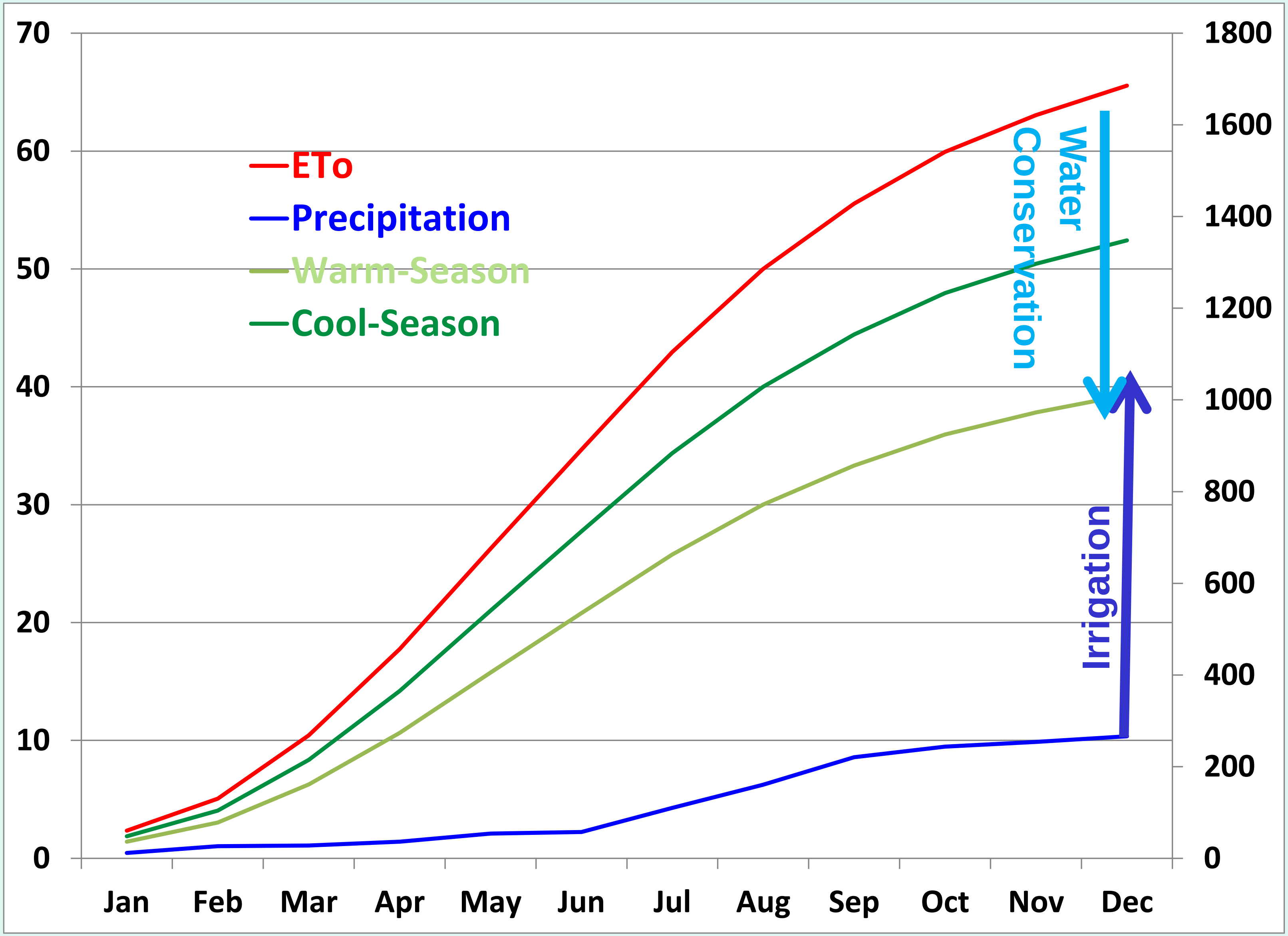
Curriculum Vitae

- Undergraduate in Agriculture, University of Munich – Weihenstephan and in Agricultural Biology, University of Hohenheim, Stuttgart
- MSc and PhD University of Hohenheim, Stuttgart
- Post Doc at Michigan State University
  Topic: Soil moisture distribution in USGA putting greens
- New Mexico State University since 2000
- Research emphasis on turfgrass water conservation:
  - Irrigation efficiency
  - Effect of environmental stresses on warm- and cool-season turfgrasses
  - Non-potable (saline, treated effluent) irrigation water

Michigan State University (1997 – 2000), East Lansing, MI



Turfgrass Irrigation Requirement
Las Cruces, NM (2005 – 2009)



Curriculum Vitae (contd.)

- Undergraduate University of Munich – Weihenstephan and University of Hohenheim
- MSc and PhD University of Hohenheim
- Post Doc at Michigan State University
  Topic: Soil moisture distribution in USGA putting greens
- New Mexico State University since 2000
  Research emphasis on turfgrass water conservation
- 68 peer reviewed journal publications (varying IF)
- 3 million $ in research grants and >1 million $ in unrestricted gifts
- RG Score 23.58 and *h*-Index 8

Raise the societal profile of turf (and turf research)

- Green space and turfgrasses around human settlements for centuries
- Management practices under scrutiny because of environmental concerns
- Do benefits outweigh concerns?
- Can we settle for a sustainable maintenance approach?
- **Vision: Green Deal**
- **Duurzaam speelkwaliteit (sustainable playing quality) /**

Research (1)

Objective: Investigate methods for a pesticide free turfgrass management approach

Goal: Empower the Green Deal

Sustainable (Integrated) Turfgrass Management

- Plant Selection
- Fertilization
- Water Management
- Other cultural practices (rootzone management, rolling, …)
- Collaboration with stakeholder / Industry groups
  - DTRF
  - Affiliated Associations (Greenskeeper, Owner, Manager, …)

Research (2)

Objective: Raise the societal profile of turf

Goal: The whole is greater than the sum of its parts

- **Topics:**
  - Water and soil quality
  - Carbon sequestration
  - Green Cities
  - Urban Heat Island / Urban climate
- Collaboration with various chair groups in Plant Sciences and Environmental Sciences

Turf Selection for Disease Control

Poa supina not affected by Fusarium Blight Syndrom (Necrotic Ring Spot)

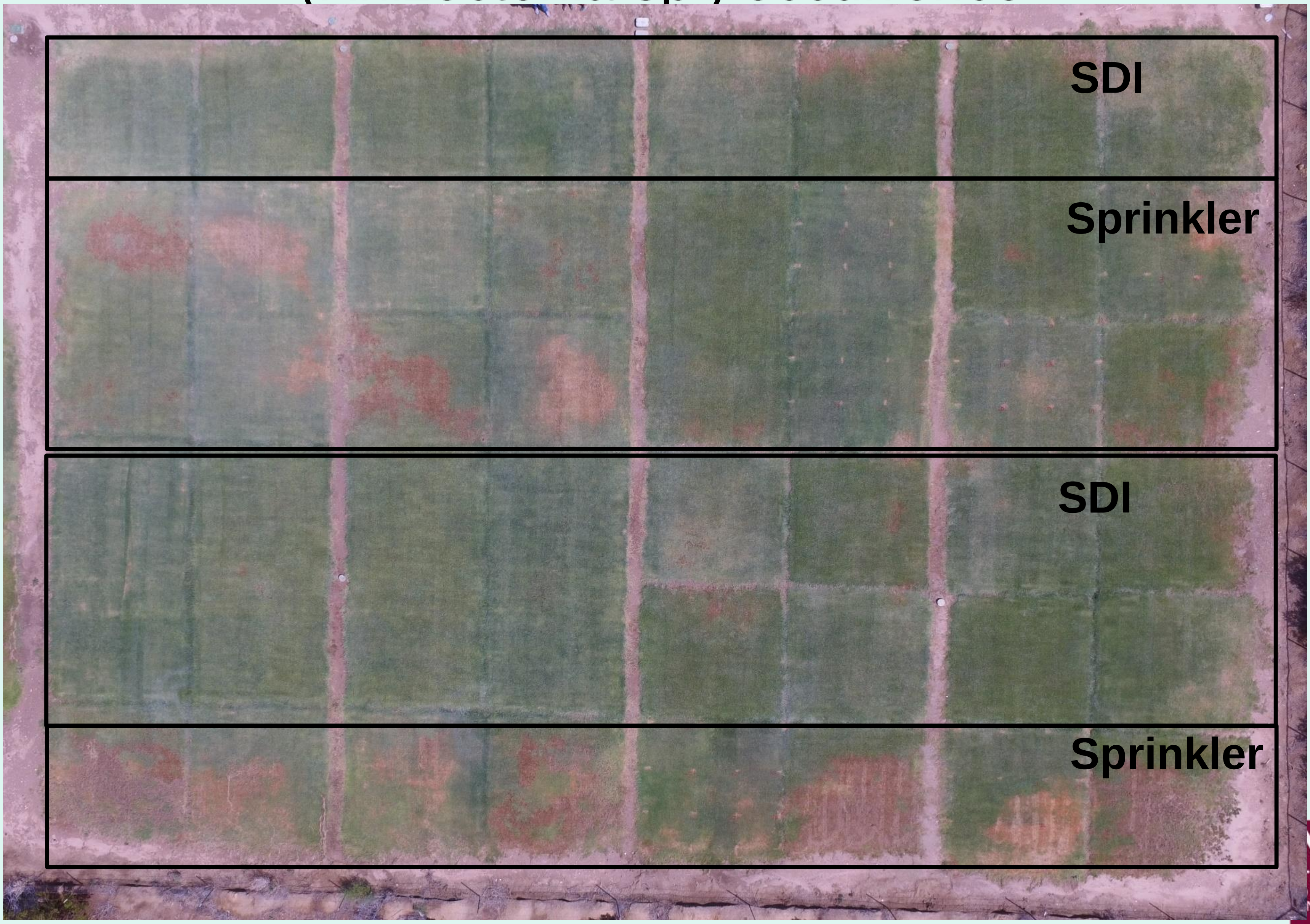
Turf Selection for Weed Control

Allelopathic Effects of Fine Leaf Fescues

Turf Management for Disease Control

Courtesy Thom Nikolai, MSU

Water management effect on brown patch (Rhizoctonia sp.) occurrence



Raise the societal profile of turf (and turf research)

Subsurface-Applied Tailored Water in Turfgrass

Lawns and turfgrass areas in the U.S. cover about 200,000 km² and may represent the single largest irrigated crop, an area three times larger than that of corn. Turfgrass areas require nitrogen (N) inputs to achieve the desired aesthetic appearance and optimal performance, and in many parts of the U.S., also supplemental irrigation. However, application of N fertilizers at rates that exceed plants requirements can result in the loss of N. Furthermore, declining water resources have forced many communities to critically evaluate how water is being used in the urban sector, particularly as a large portion is consumed for landscape irrigation, which is considered non-essential.

Therefore, developing and implementing proper fertilization and water conservation strategies for turfgrass areas has become a critical issue for both municipalities and the turfgrass industry. In the September–October issue of Crop Science, New Mexico State University turfgrass expert Bernd Leinauer and co-author Elena Sevostianova detail their perspective on the way forward: decentralized water treatment, drip irrigation, and fertigation.

Unlike potable water reserves, quantities of reclaimed wastewater continue to increase due to population growth, can provide a readily available source of irrigation for arid and semi-arid areas, and eliminate the need of potable water for irrigation. Adopting more effective irrigation systems can also help in reducing the amount of potable water used for turfgrass irrigation. Although sprinkler systems are the most commonly used irrigation systems for turf-dominated landscapes, they can have significant losses from runoff, wind drift, and evaporation. Subsurface irrigation systems, on the other hand, apply water directly to the root zone, thereby avoiding problems such as overspray, runoff, wind drift, and human exposure.

Fertigation involves the continuous injection of small amounts of liquid fertilizer into the irrigation stream. Studies have shown that such a method of fertilization appears to greatly reduce the risk of potential nitrate leaching. However, for fertigation to be more effective and thereby accepted, it needs to be coupled with an irrigation system that applies water uniformly, and the fertilizer injection system must be able to adjust nutrient delivery to correspond with plant requirements, thereby minimizing leaching.

Decentralized wastewater treatment technologies offer the ability to produce recycled water with varying quantities of N on relatively short notice, and using such tailored water would reduce or eliminate the need for additional mineral fertilizers if concentrations of nitrate in the water were raised during the growing season to meet the annual N requirement. However, in areas with high rainfall reaching or exceeding the overall irrigation requirement for several months of the growing season, the use of tailored water to supply N needs to be more thoroughly studied. Investigating the effects of increased N levels in irrigation water may also be important during hot summer months, when leaching fractions are typically increased to flush accumulated salts in the root zone but N requirements of the plants are low due to a slowing down in growth caused by heat stress.

Based on their model estimates and available research data, the researchers generally consider the use of tailored water as an effective and safe means to provide both irrigation and N to turfgrass areas. However, most if not all of the available data are based on studies for which irrigation water was applied to turfgrass areas from sprinkler systems. More research is needed to investigate the effects of tailored water on turfgrass quality and nitrate leaching if irrigation is applied from the subsurface. Applying the tailored effluent using subsurface drip would ensure irrigation distribution uniformity and might help allay any public fears about human contact with recycled water. Additionally, more research is needed to determine if tailored water could also be used to irrigate and fertilize native and low-maintenance grasses, as no data are available on their assimilative capacity.

The authors conclude that new existing water treatment technologies that can adjust the nutrient content in effluent water could provide the means to sustain turfgrass areas with non-potable, recycled water and reduce or even eliminate the need for mineral fertilizers.

Adapted from Sevostianova, E., and B. Leinauer. 2014. Subsurface-applied tailored water: Combining nutrient benefits with efficient turfgrass irrigation. Crop Sci. 54(5). View the full article at http://dx.doi.org/doi:10.2135/cropsci2014.01.0014

Turfgrass test plots at New Mexico State University. Grasses irrigated with tailored water are on the right side; plots on the left side are irrigated with potable water and fertilized with calcium nitrate. Photo courtesy of Bernd Leinauer.

doi:10.2134/csa2014-59-9-5

Outreach activities

- Publications
- Social Media
- Presentations / Meetings

Tournament preparation with USGA

Teaching

1) Introduction to Turf (BSc)
2) Advanced Turfgrass Management (BSc and MS)
3) Turfgrass Soils and Nutrient Management (BSc and MS)
4) From Project Design to Presenting and Publishing (MS) (Seminar Course / Special Topics)
5) Statistical Analysis of Field Data (MS) (Seminar Course / Special Topics)

Coordinating with faculty in other programs to determine greatest need

Research Topics

1. **Visual Turfgrass Quality Revisited**
2. **Surfactants for Turfgrass Water Conservation**

1. Visual Turfgrass Quality Revisited

<u>Study:</u>

- Leinauer et al., 2014. Digital Image Analysis and Spectral Reflectance to Determine Turfgrass Quality. Agronomy Journal 106:1787–1794

<u>Problem:</u>

- Turfgrass quality describes an (subjective) aesthetic appeal
- Visual assessment from 1 = worst to 9 = best
- Data are subjective, collected on an ordinal scale
- Statistical analysis by means of ANOVA is questionable but has been accepted
- Comment was made that between 3 and 5 scientists are needed to publish results

Study

Generalizability Study

- Definition: Examine the extent to which a finding can be applied to the larger population of which the sample was a part
- Used to determine the reliability (i.e., reproducibility) of measurements under specific conditions, particularly for evaluating the reliability of (subjective) performance assessments (Cronbach et al., 1963; Wikipedia, 2014).
- How many raters (or replicate plots) are needed to determine turfgrass quality?
- Objectives:
  1) To determine the number of scientists necessary to achieve a reliability of 0.7 or greater
  2) Can a similar reliability be achieved by increasing replication

Materials and Methods (1)

Cool-season drought trial

1. Tall fescue [*Schedonorus arundinaceus* (Schreb.) Dumort.] 10 var.
2. Perennial ryegrass (*Lolium perenne* L.) 7 var.
3. Kentucky bluegrass (*Poa pratensis* L.) 7 var.
4. Irrigation applied at 115%, 100%, 85%, 70%, 55% ETos
5. CRBD, 4 replications (480 plots)

Materials and Methods (2)

- 5 Raters with varying years of experience:
  27, 16, 8, 7, 1
- Turf quality (1 to 9, 1 = worst and 9 = best), monthly from June to October 2014
  (Krans and Morris, 2007)
- Includes cover, uniformity, shoot density, leaf texture, leaf orientation, smoothness, and color
- Normalized Difference Vegetation Index (NDVI) GreenSeeker Model 505 (NTech, Ukiah, CA)
  (Bell et al., 2009)
- Digital Image Analysis
  (Ikemura, 2003; Karcher and Richardson, 2003, 2005, 2013)

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Materials and Methods (3)

Generalizability Study

Statistical Approach

1) Computation of reliabilities for relative decisions
   (Cronbach et al., 1972; Shavelson and Webb, 1991)

2) ANOVA to estimate variance (V) components:
   - Evaluator (e)
   - Irrigation (i)
   - Variety (v)
   - Replication (r)
   - Random factors: r, i∗v, e, i∗v∗e, r∗i, and r∗i∗v

(Horst et al., 1984)

Materials and Methods (4)

Reliability (R): $R = \frac{V(i*v)}{V(i*v) + \text{relative error}}$

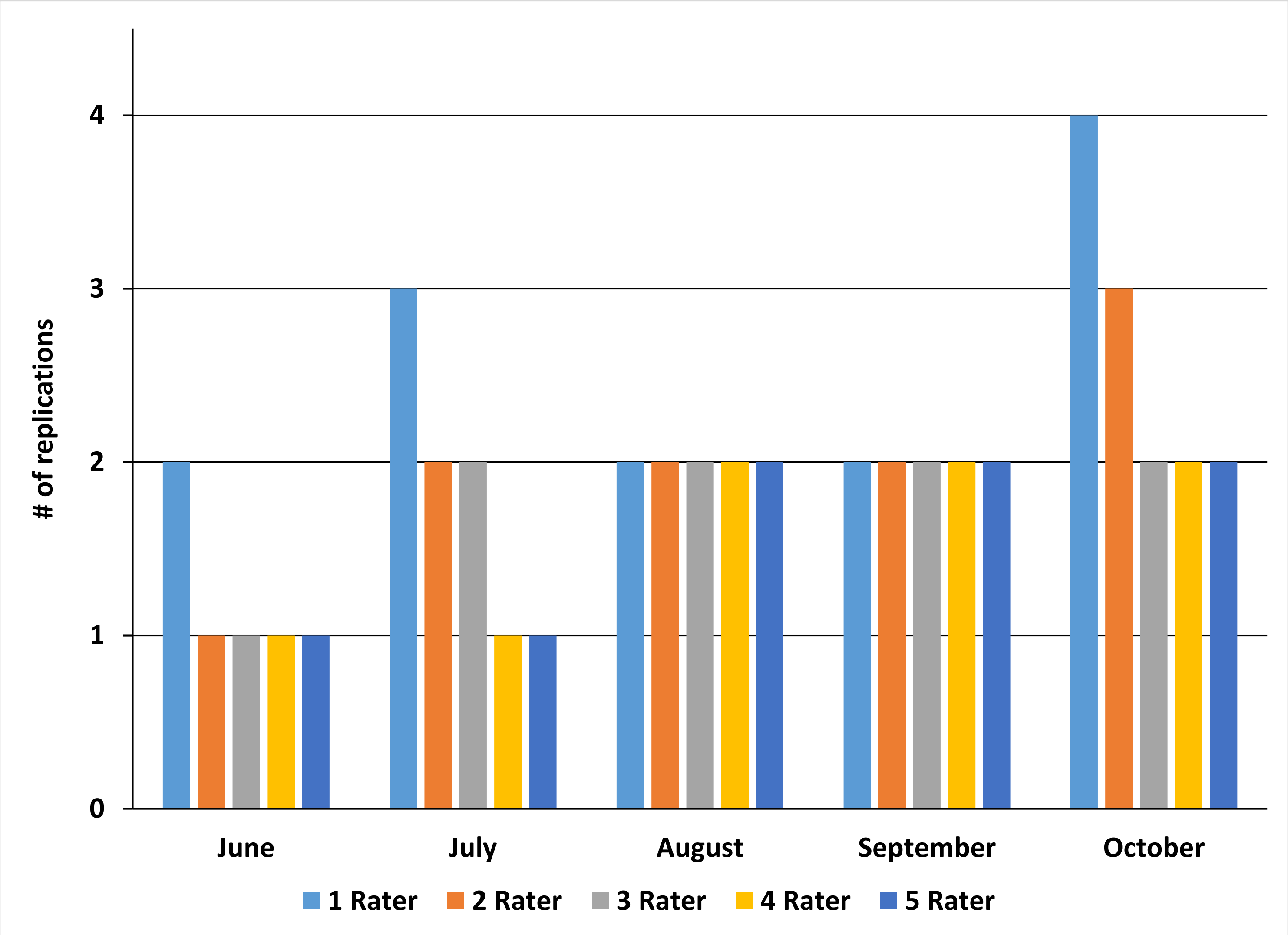
Relative error: $\frac{V(r*i)+V(r*i*v)}{\#r} + \frac{V(i*v*e)}{\#e} + \frac{V(error)}{\#r*\#e}$

Materials and Methods (4)

- SAS Proc varcomp (version 9.3, SAS Institute Inc., 2010)
- $0.7 \leq R \leq 0.8$ sufficient for most studies
- Few studies require $R \geq 0.8$
- “For basic research … increasing R beyond 0.8 is often wasteful of time and funds.” (Nunnally, 1978)
- Relative error can be reduced by increasing either replications or evaluators
- Pearson’s correlation coefficient (SAS PROC CORR) was used to determine association between visual quality data of raters and between NDVI, DGCI, and Cover and visual quality

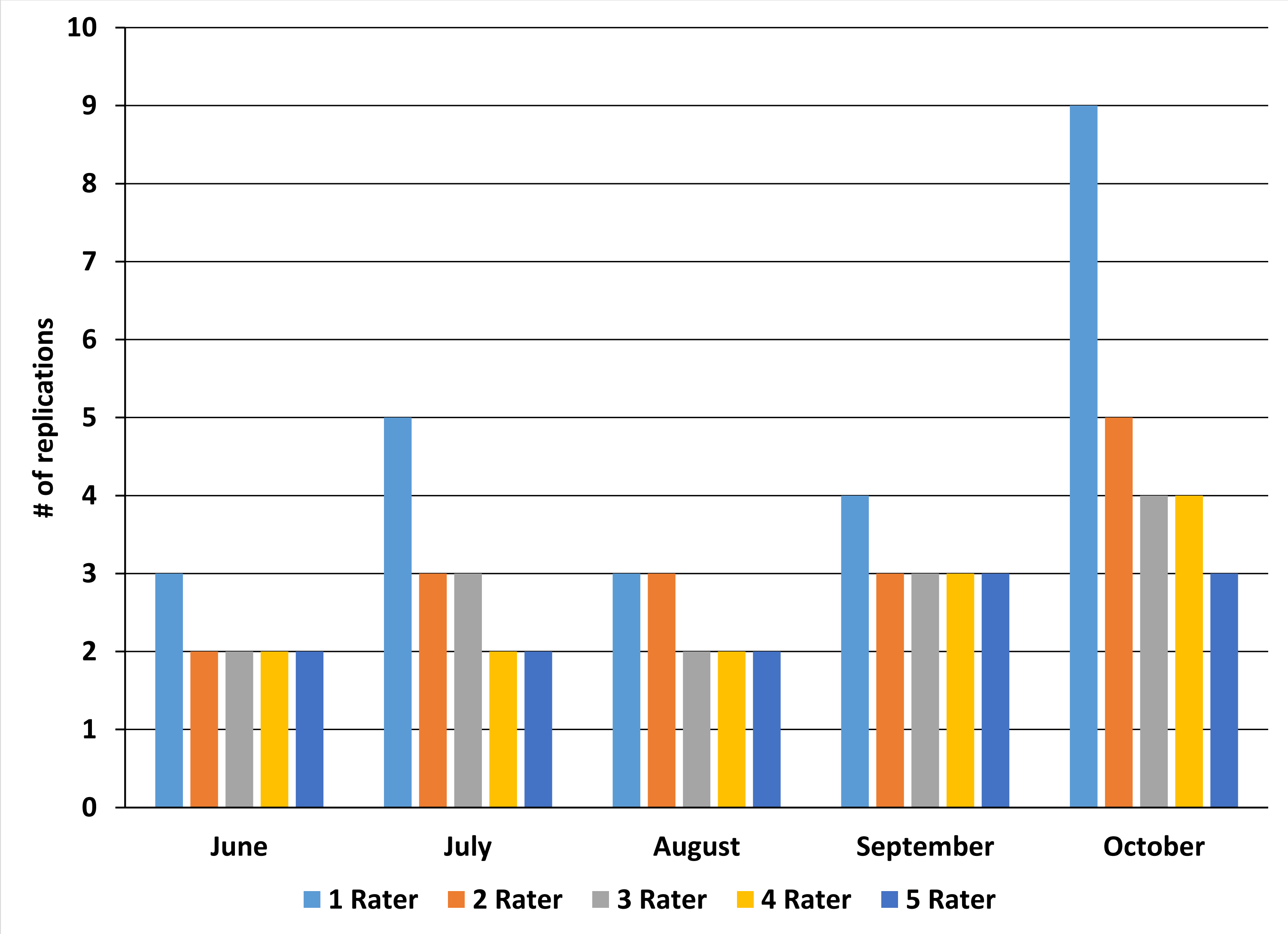
Results (1)

Number of raters and replications to achieve R = 0.7



Results (2)

Number of raters and replications to achieve R = 0.8



Results (3)

Visual quality relationship (correlation coefficient r) between different raters

		June	July	August	September	October	Jun – Oct
R1	R2	0.89	0.91	0.91	0.78	0.85	0.87
R1	R3	0.94	0.95	0.95	0.98	0.85	0.93
R1	R4	0.88	0.61	0.91	0.93	0.81	0.82
R1	R5	0.83	0.81	0.83	0.81	0.69	0.72
R2	R3	0.89	0.90	0.90	0.77	0.71	0.83
R2	R4	0.86	0.58	0.86	0.78	0.71	0.76
R2	R5	0.78	0.80	0.81	0.74	0.71	0.71
R3	R4	0.89	0.63	0.90	0.92	0.71	0.80
R3	R5	0.81	0.80	0.84	0.81	0.60	0.69
R4	R5	0.78	0.50	0.85	0.81	0.57	0.66

Summary

- One rater and 4 replicate plots are sufficient to achieve a reliability of 0.7
- If a reliability of greater than 0.7 is desired, more than 1 rater or >4 replications are needed
- Visual assessments of experienced raters are strongly correlated
- Associations between NDVI, Cover, and DGCI with visual quality are only slightly strengthened if 5 raters are used
- Manuscript under review for a note in Crop Science

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Water repellency in turfgrass root zones

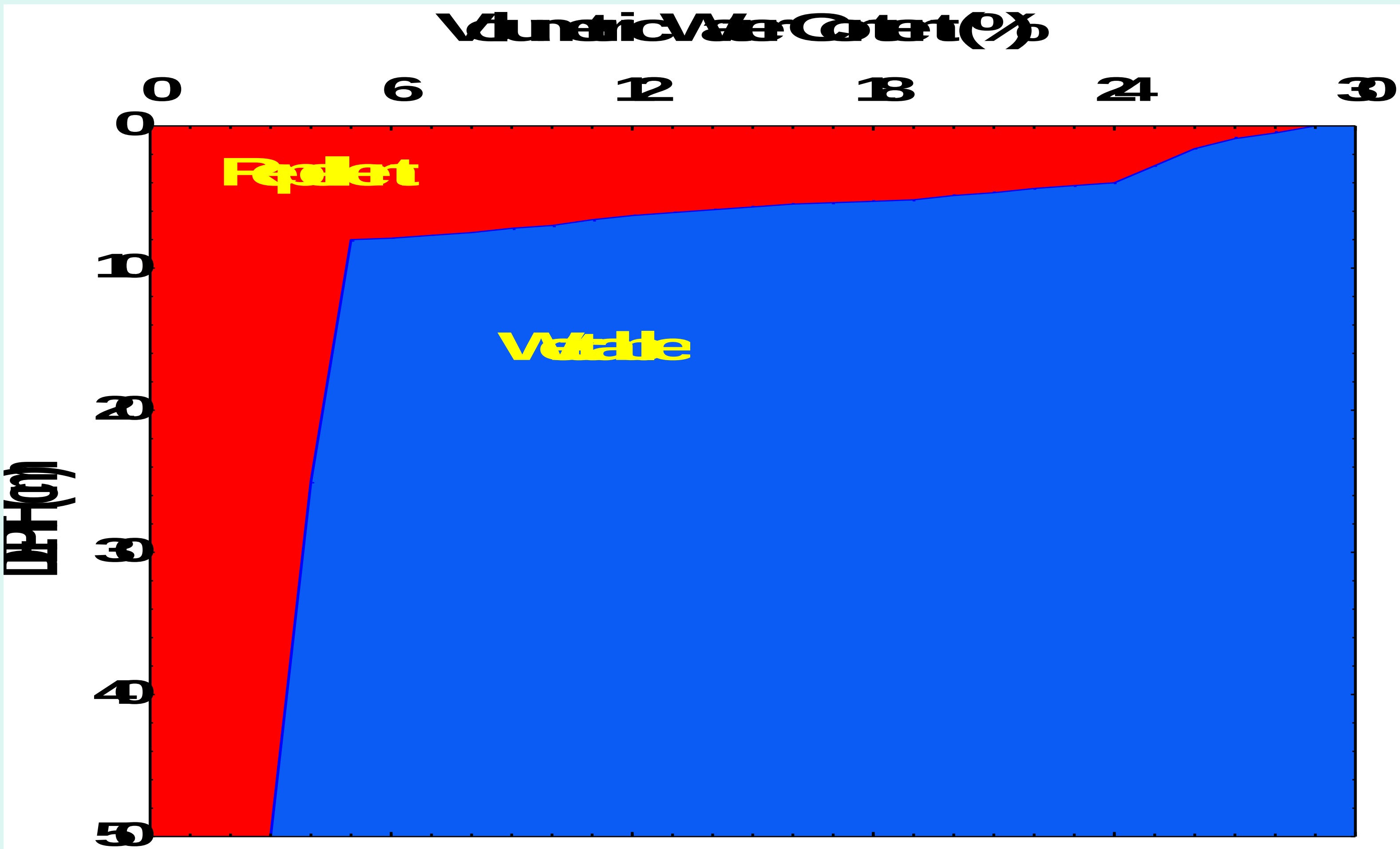
Localized Dry Spot

Karnok and Beall, 1995

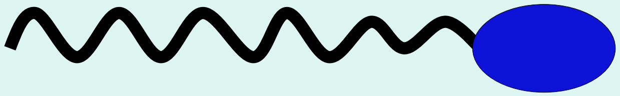
Karnok and Tucker, 2000

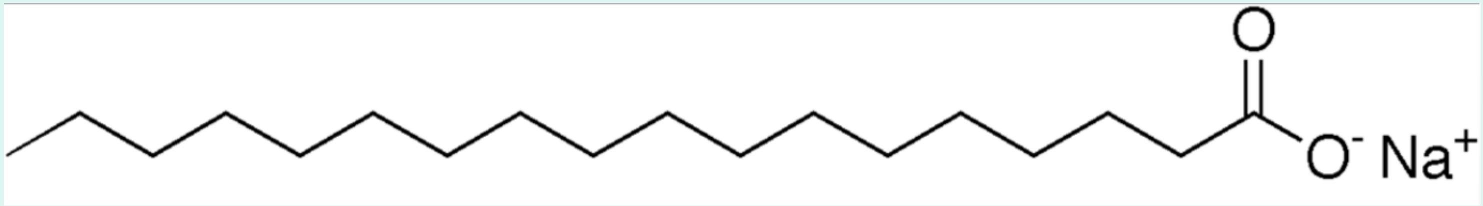
Critical Soil Water Content

Threshold below which a soil is water repellent and above which the soil is wettable (Dekker et al., 2001)

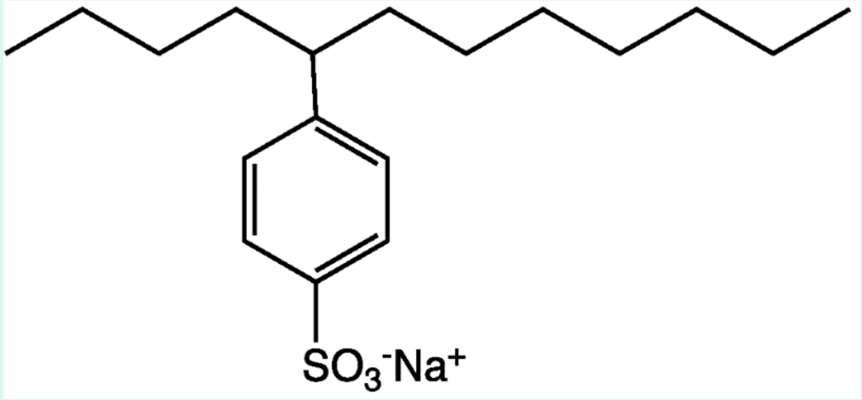


Surfactants

Hydrophobic tail  hydrophilic head



Sodium stearate, the most common component of soaps



4-(5-Dodecyl) benzenesulfonate, a linear dodecylbenzenesulfonate, another very common surfactant

(en.wikipedia.org/wiki/Surfactant)

Soil Surfactants – Background

Surfactants:

- Moisture distribution and rootzone wetting changes from preferential to uniform
- Infiltration and soil moisture increases in surfactant treated turfgrass rootzones (Leinauer et al., 2001; Miller, 2001; Mitra et al., 2004).
- Run off and deep percolation decreases
- Irrigation requirement decreases

Sand Topdressing

- Smooth surface, playability
- Organic matter management
- Hydrophobicity?

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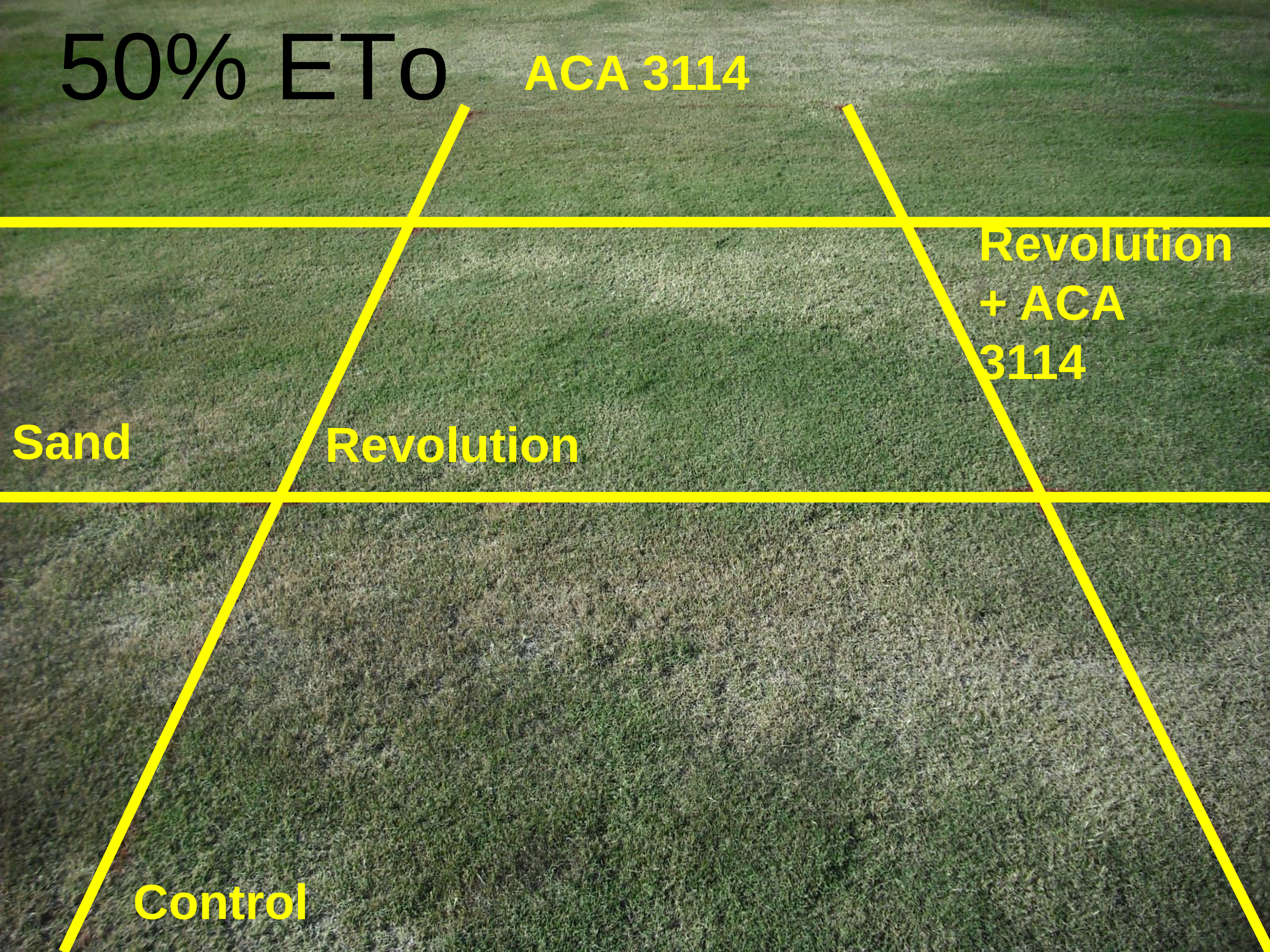
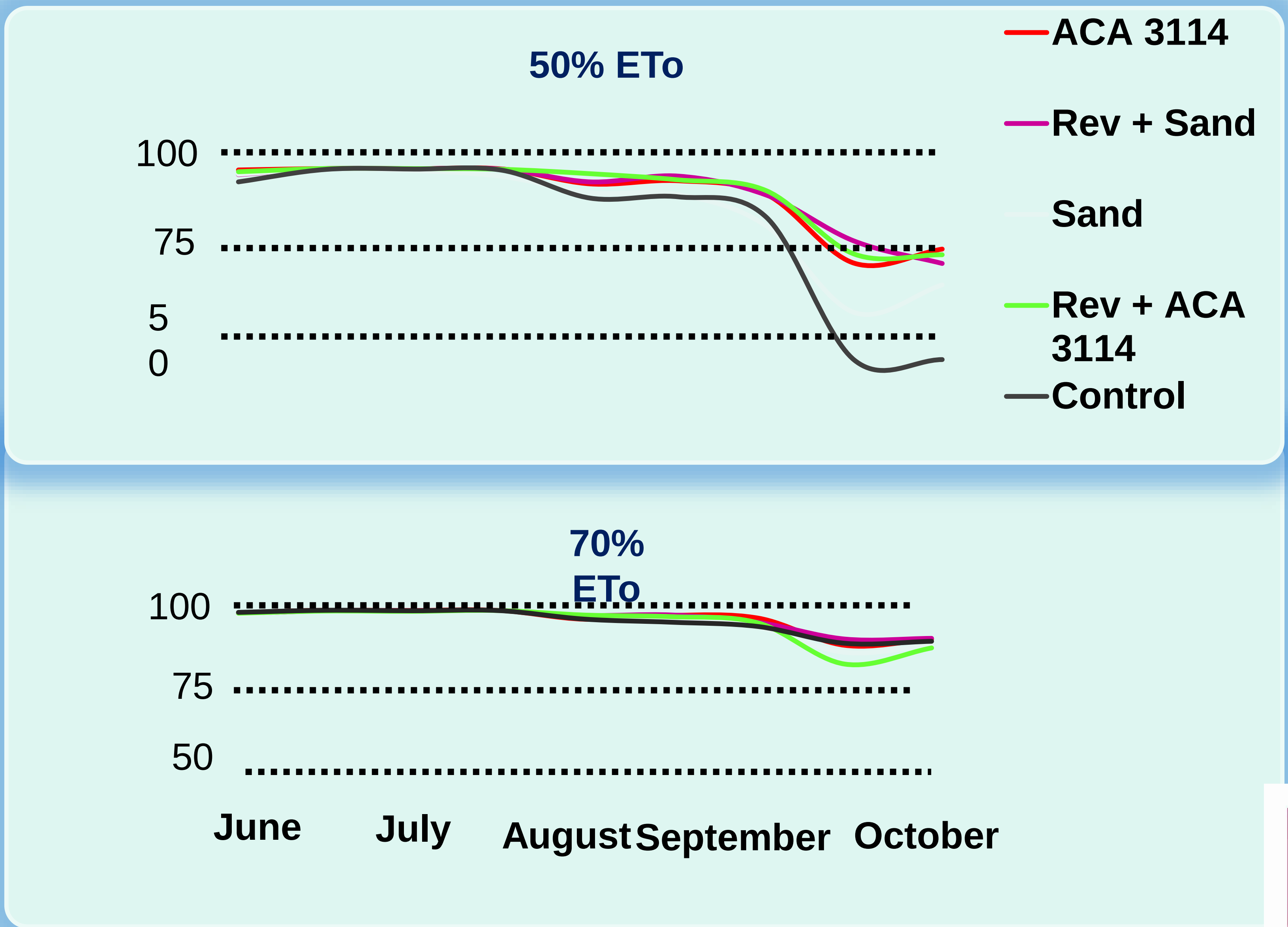

50% ETo
ACA 3114
Revolution + ACA 3114
Sand
Revolution
Control

Green Cover (%)


50% ETo
100
75
5
0
ACA 3114
Rev + Sand
Sand
Rev + ACA 3114
Control
70% ETo
100
75
50
June
July
August
September
October

Results / Summary

1) Turf treated with both experimental and market available soil surfactants exhibited acceptable quality under reduced irrigation
2) Increase in soil moisture uniformity appears to lower irrigation requirement

Alvarez et al. IN PRESS. Surfactant and Polymer-Coated Sand Effects on Deficit Irrigated Bermudagrass Turf

Future

- \+ **Aesthetic value**
- \+ **Water Conservation**
- ± **Cost Effective (?)**
- − **Coated sand currently not market available**

Dennis Kimetto (Kenia) breaks Marathon
World Record: 2:02:57 (2:55 min/km)

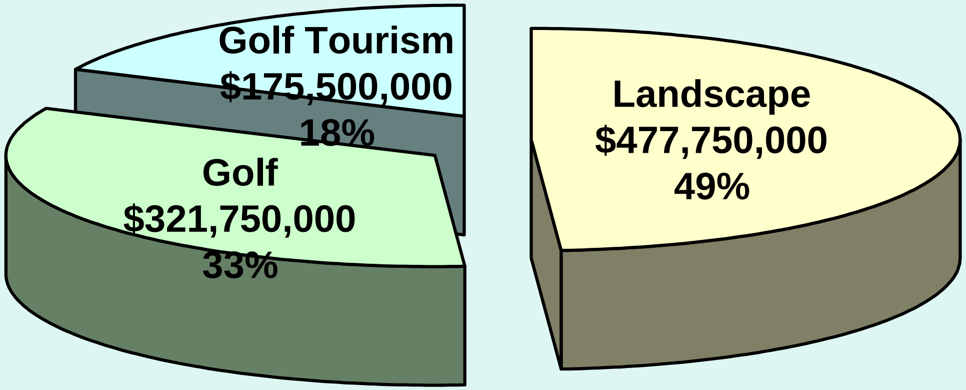
“If you want to run fast, run alone.
If you want to run far, run together.”
(African Proverb)

- Trees and vegetation lower surface and air temperatures
- Shaded surfaces may be 11–25°C cooler than the peak temperatures of unshaded materials
- Evapotranspiration, alone or in combination with shading reduces peak summer temperatures by 1–5°C

Physical Health / Mental Health

- **Exposure to Residential Green Space Improves Mental Health (***Environ. Sci. Technol.* 2014; 48(2):1247-1255)
- **More green space is linked to less stress in deprived communities: Evidence from salivary cortisol patterns** (Landscape and Urban Planning 2012; 105(3): 221–229)
- **Poor kids' higher weights linked to less access to yards, parks** (Social Science and Medicine 2012. 75).

Economic Impact of a Green Industry



<u>Economic Impact:</u>

- $1,392,000,000 total impact
- Over 20,000 jobs
- Over $400 million in personal income
- Over $83 million in tax impacts