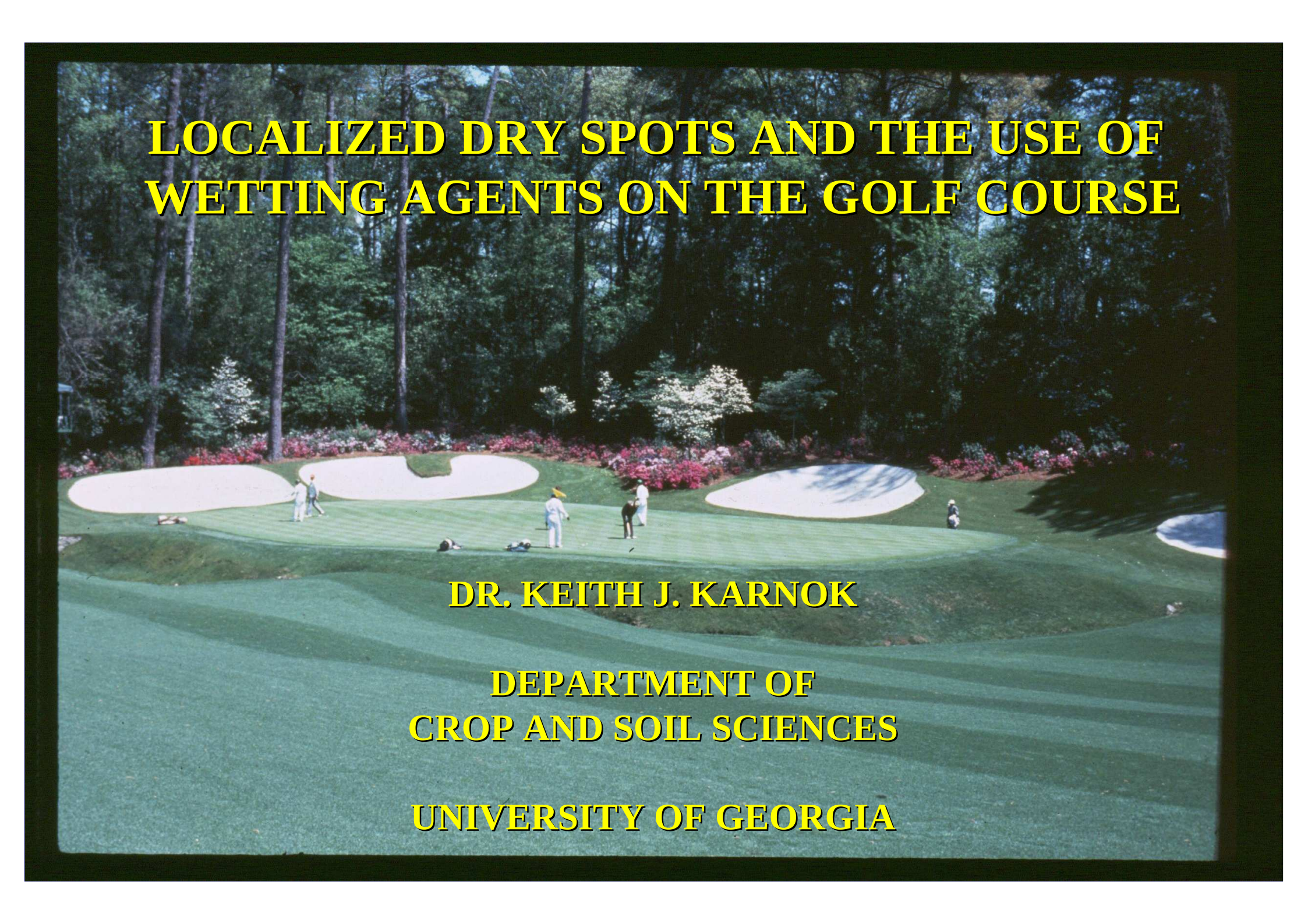




LOCALIZED DRY SPOTS AND THE USE OF WETTING AGENTS ON THE GOLF COURSE

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SURVEY OF SUPERINTENDENTS

“Do you use wetting agents as part of your regular turf management program?”

87%

**Do you or have you used a
wetting agent under
certain circumstances?**

98%

SURVEY RESULTS

- **DRY SPOTS** 42%
- **WATER MANGT.** 32%
- **DRAINAGE** 14%
- **PESTICIDE EFF.** 11%
- **OTHER** 1%

TAKE HOME MESSAGE

1

- **ESSENTIALLY ALL SUPERINTENDENTS SURVEYED USE WETTING AGENTS TO SOME EXTENT.**
- **WETTING AGENTS USED PRIMARILY FOR MANAGING LDS.**



LOCALIZED DRY SPOT

The occurrence of an irregular area of turfgrass that for no apparent reason begins to show signs of drought stress.

Overview of putting green showing loss of turf due to extreme LDS.



TAKE HOME MESSAGE #2

**“There are many
potential causes of LDS”**





**Water droplets sitting on
surface of soil core taken from LDS**

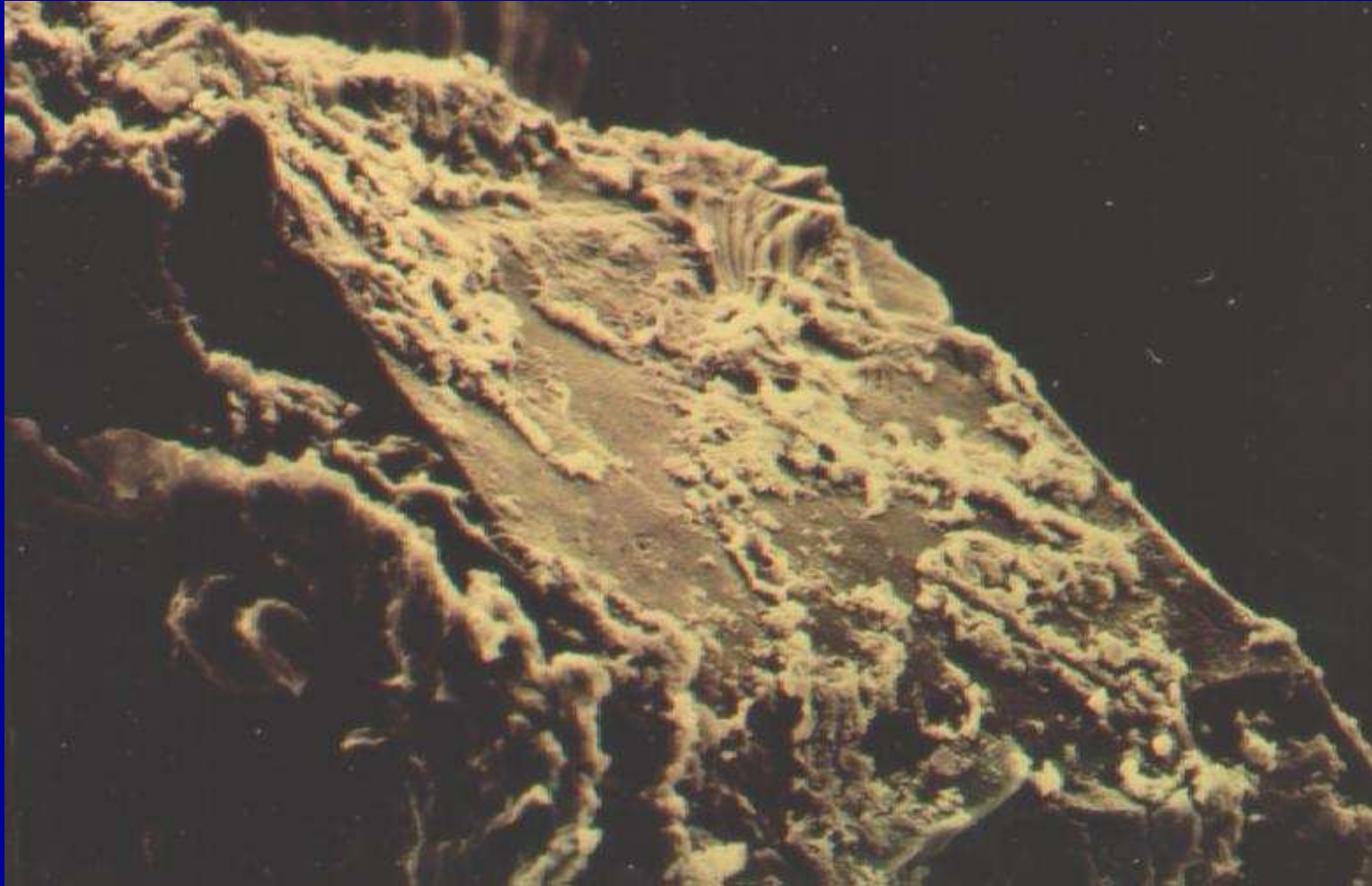


ELECTRON MICROSCOPY

**There was a difference
between sand particles
from LDS areas compared
to healthy areas.**



**Electron micrograph of sand
particle with no coating**



**Electron micrograph of sand
particle with coating**

DECOMPOSITION OF ORGANIC
RESIDUES WITH THE RELEASE
OF PLANT NUTRIENT ELEMENTS

PHOSPHORUS

CARBON

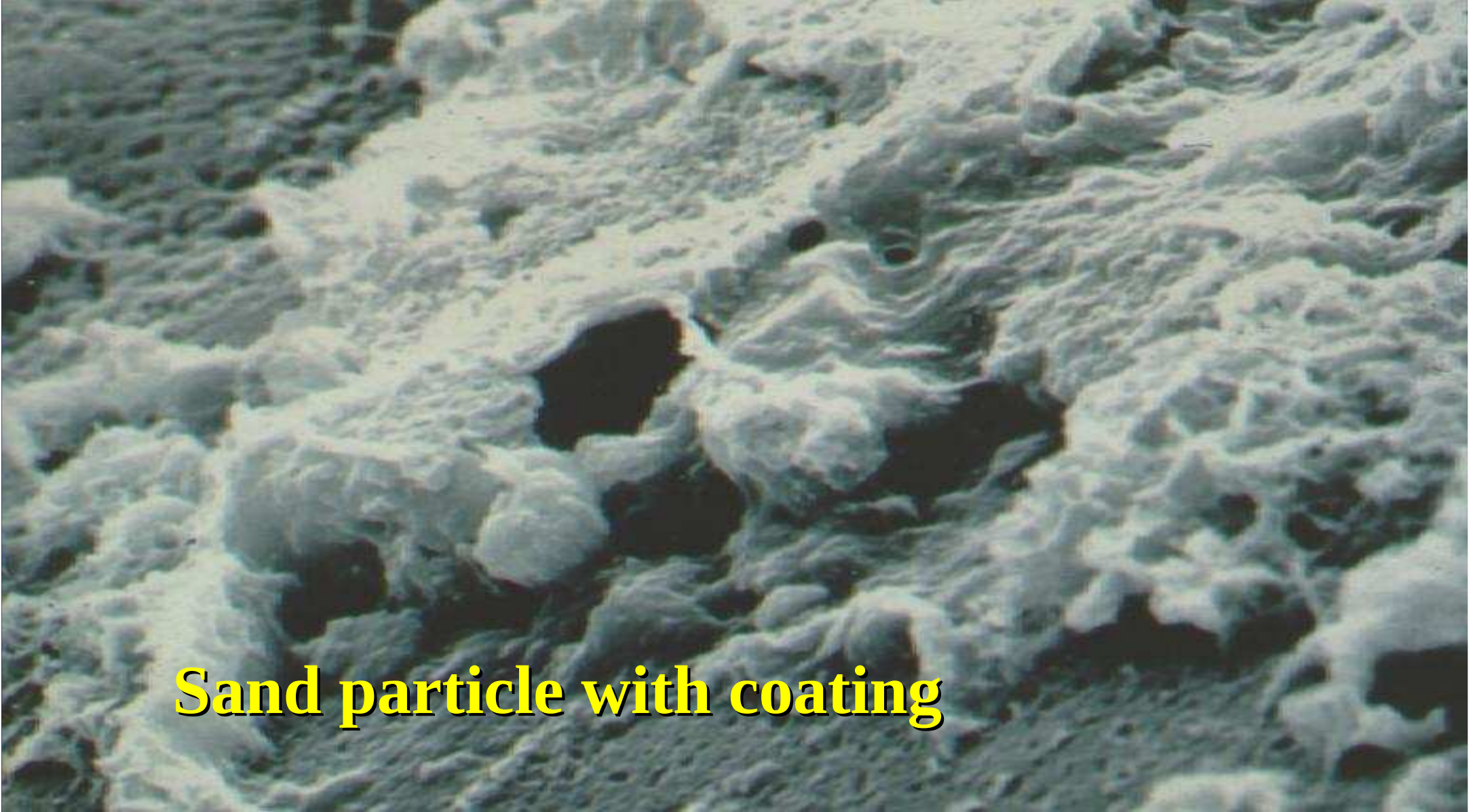
SULPHUR

NITROGEN

POTASSIUM



THESE ORGANIC COMPOUNDS, WHEN ALLOWED TO DRY, BECOME VERY WATER REPELLENT.



Sand particle with coating

A scanning electron micrograph (SEM) showing a sand particle with a coating. The particle is irregular in shape and has a rough, textured surface. The coating appears as a darker, more uniform layer on the surface of the particle. The background is a lighter, granular material.

TAKE HOME MESSAGE #3

**“Organic coating is
hydrophobic when dry and is
result of organic matter
decomposition”**



QUESTION?

**Can the organic
coating be practically
removed ?**

TAKE HOME MESSAGE #4

**“Organic coating
can not be prevented
or (practically) removed”**



TAKE HOME MESSAGE #5

“Coarse textured soils (sand) are most prone to becoming water repellent”





**Tends to be a
surface
phenomenon
top 2 inches**

**(Up to 6 inch
depth)**

QUESTION

**“Is LDS a greater problem today
than 25 years ago?”**

YES, NO, MAYBE??

Factors contributing to increased LDS caused by water repellent soil

- 1. Lower cutting height (shorter root system, greater stress)**
- 2. Prolific organic matter producing cultivars**
- 3. Decreased cultivation and topdressing practices**
- 4. Increased play and golfer expectations**



**Degree of
water repellency
varies across green
(mild to severe)**

Depth (in.)	VWC	
0.5	8.0	18.0
1.5	1.3	15.8
2.5	2.0	3.9
3.5	1.2	1.0
4.5	1.0	0.9

Depth (in.)	VWC	
0.5	15.1	12.3
1.5	17.0	16.5
2.5	6.6	9.9
3.5	2.5	3.8
4.5	1.4	1.2

TAKE HOME MESSAGE #6

“Degree of water repellency varies across green and usually occurs in top 2 inches of profile.”



**MANAGING TURFGRASSES
GROWING ON WATER
REPELLENT SOILS**

WHAT WOULD BE THE PRIMARY GOAL MANAGEMENT WISE?

CLUE:

**Water repellency occurs in
top 2 inches of soil profile.**

A close-up photograph of a person's hands holding two soil cores. The left hand holds a small, dark, moist soil core. The right hand holds a much larger, elongated soil core, showing its internal structure and roots. The person is wearing a silver metal watch on their right wrist. The background is a solid blue color.

PRIMARY MANAGEMENT PRACTICES

- 1. Select best species/cultivar**
- 2. Reduce nitrogen**
- 3. Increase cutting height**
- 4. Irrigate properly**
- 5. Strict cultivation and topdressing program**

TAKE HOME MESSAGE # 7

**Strive for deep root system
(beyond top 2 inches) via:**



WETTING AGENTS

WETTING AGENTS

Wetting agents help to temporarily alleviate the symptoms (LDS) of water repellent soil.

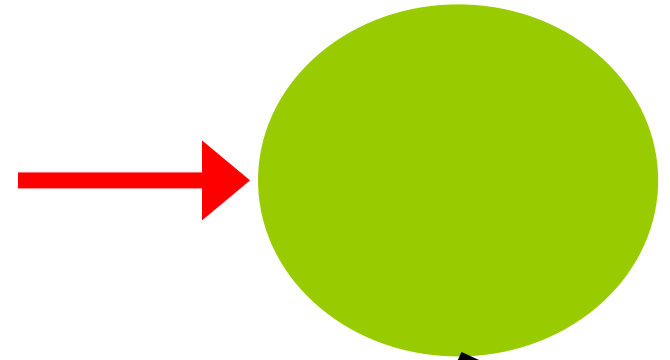
TAKE HOME MESSAGE #8

“Currently, wetting agents are the best tool for managing water repellent soils.”

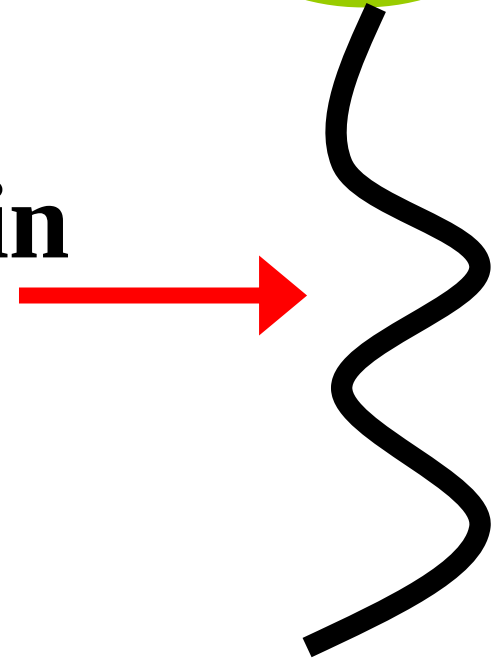


SURFACTANTS HAVE ...

**1. Water soluble group
(hydrophilic/polar)**

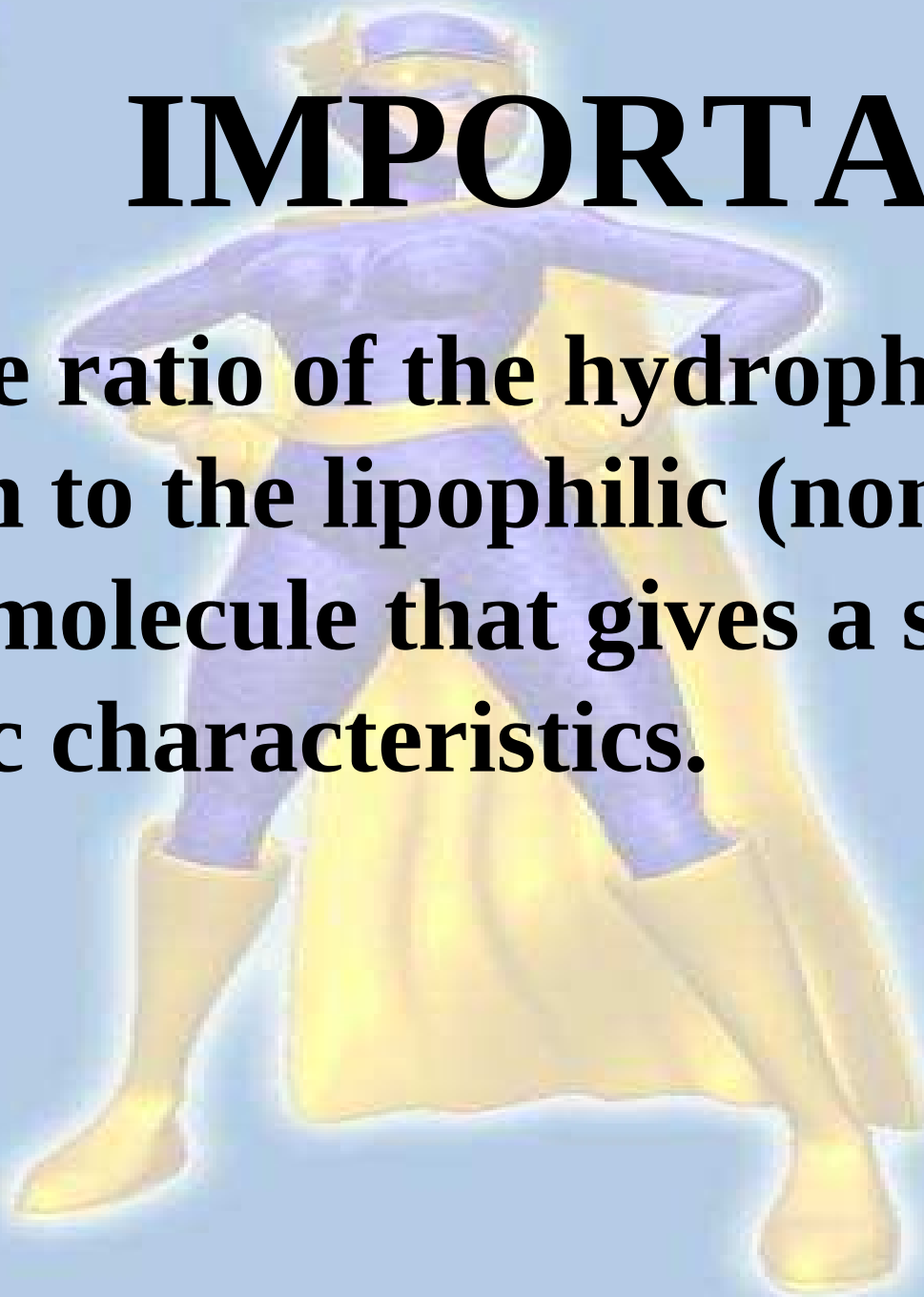


**2. Oil soluble hydrocarbon chain
(lipophilic/nonpolar)**



IMPORTANT

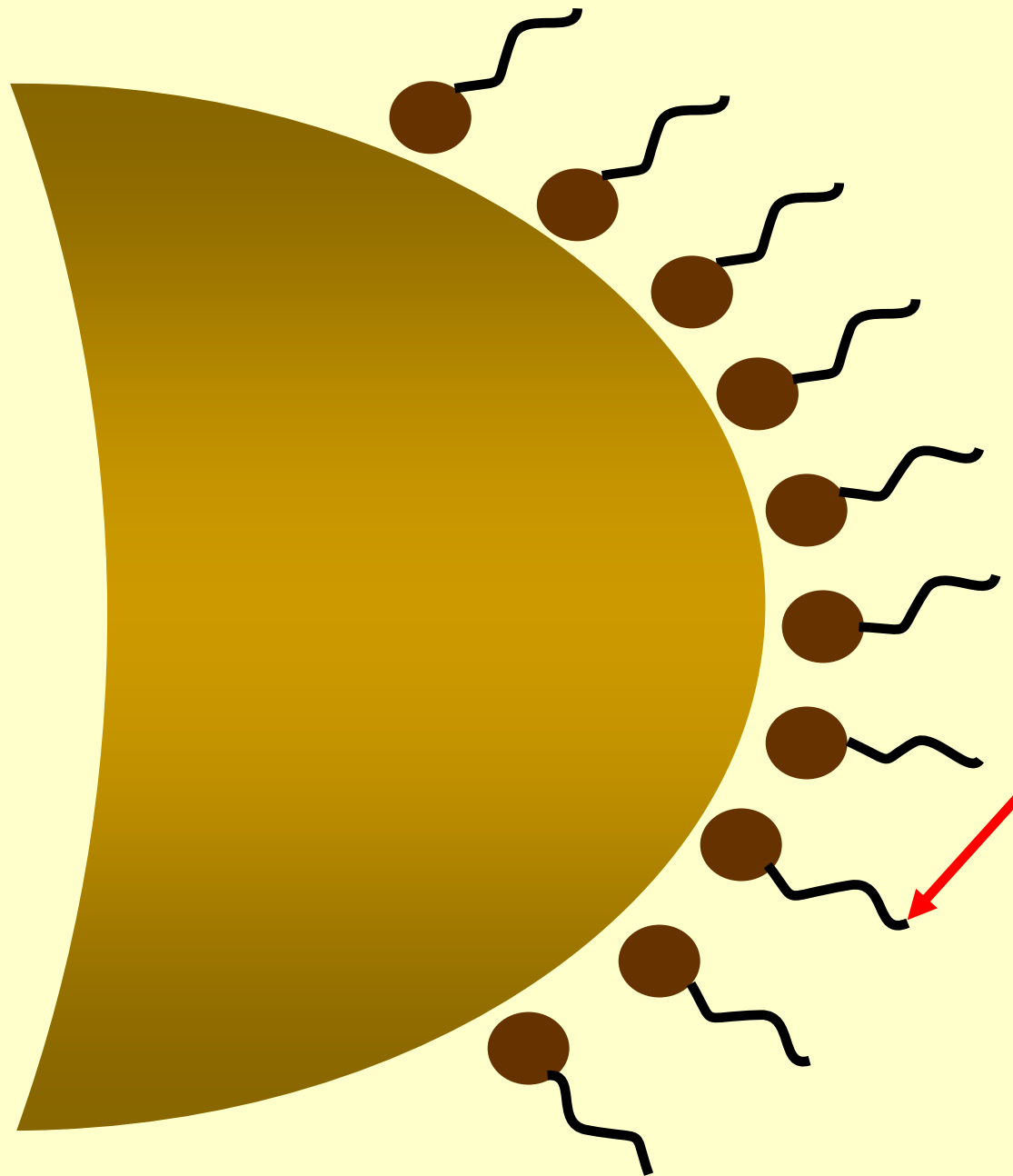
- It is the ratio of the hydrophilic (polar) portion to the lipophilic (nonpolar) portion of the molecule that gives a surfactant its specific characteristics.



THOUSANDS OF POTENTIAL COMBINATIONS

9,27,34	44,19,2
49,3,21	60,14,30
13,51,10	7,4,36
44,19,2	9,27,34
60,14,30	49,3,21
7,4,36	13,51,10

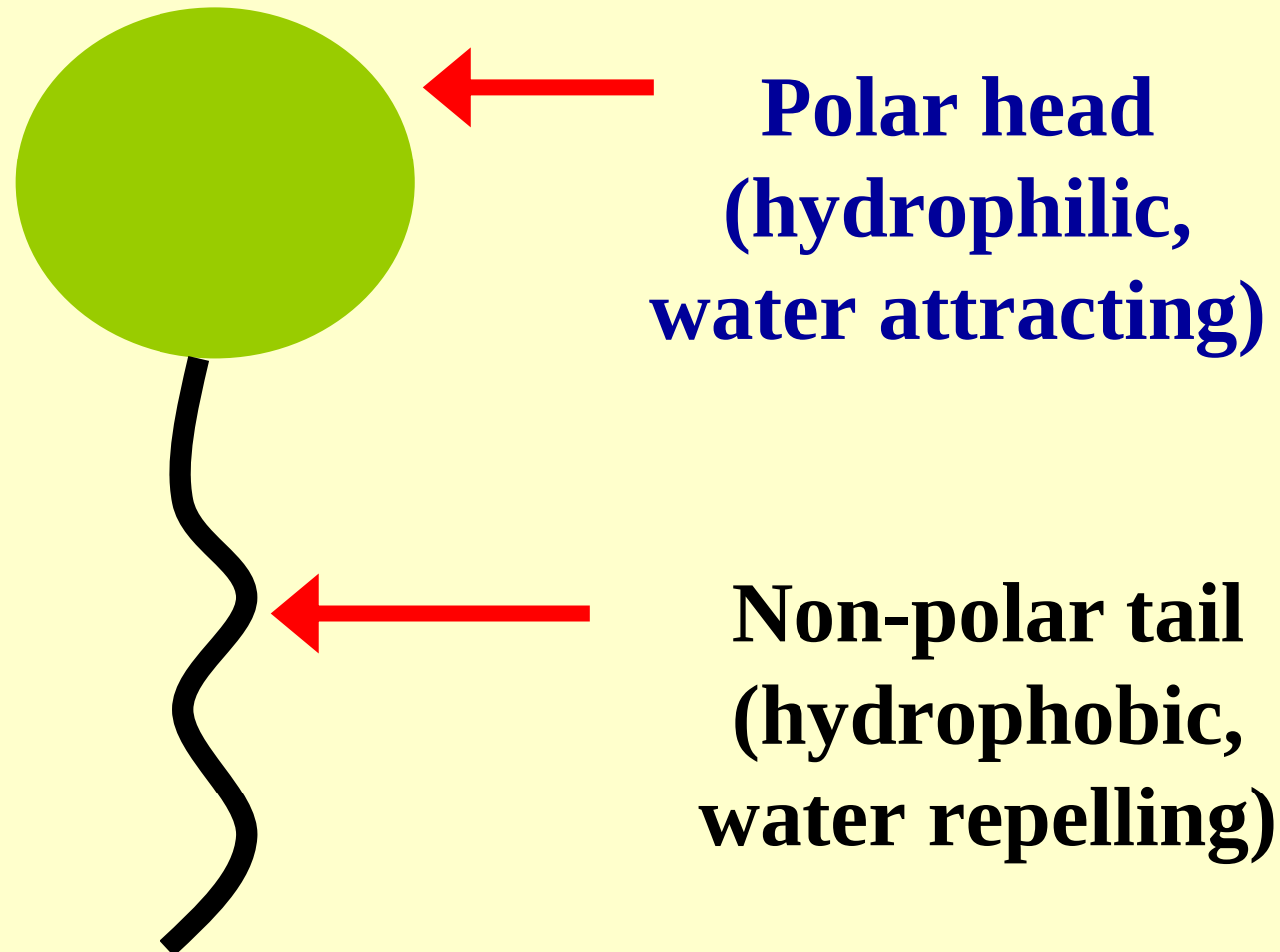
**What happens when
a wetting agent is
added to a
hydrophobic soil?**



**Sand grain
with organic
coating**

**Non-polar end
(will repel
water)**

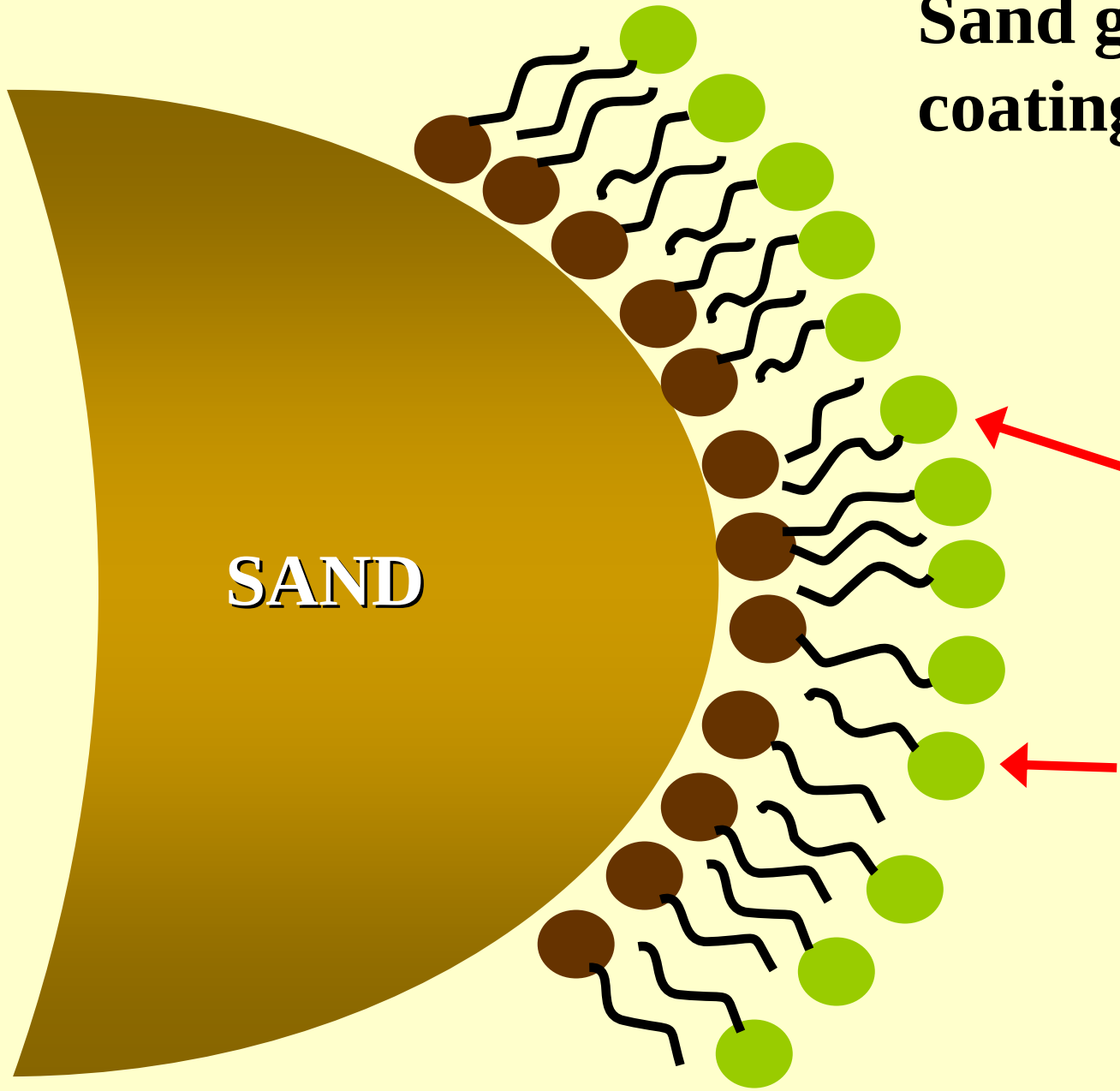
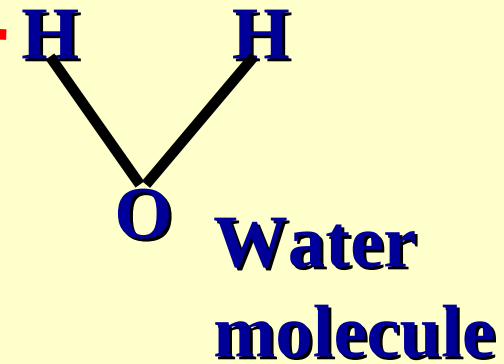
WETTING AGENT MOLECULE



**Sand grain with organic
coating plus wetting agent**

**Wetting agent
polar head
(attracts water)**

SAND



VIDEO



TAKE HOME MESSAGE # 9

**“Wetting agents adsorb
to the organic coating.”**



**What is the number one question
superintendents want answered
about soil wetting agents?**

COMMON WETTING AGENTS

Action 99

Advantage

Affinity

Alleviate

Aqua Maxx

Aqua Root

Aqua Zorb

Aqua-Aid

Aqua-Drive

Aqua-Root

Aqueduct

Aquifer

Big Sur 90

Big Water

Big Wet

Break-Thru

Brilliance

Cadence

Canteen

Capacity

Carbo-Aid

Cascade Plus

Chempro S-163

Chempro S-172

Chem-Stik

Cide-Kick

Cide-Kick II

Clearing

Command

COMMON WETTING AGENTS

Conduit 90

DI Aqua

Dispatch

Drench

Duplex

Dura-Wet

Dyne-Amic

Easy Wetta

Excel 2000

EZ Wet

Faststrike

First Choice

Break-Thru

Fleet

Flo Thru

Freeway

Galactic

Gateway

Generation

GenerationCG

Guardian

H2OLD

H2Pro

Hydraflo L

Hydrate

Hydration

Hydretain

Hydrix

Hydro-Max

Hydro-Wet

COMMON WETTING AGENTS

Impact
Induce
Inergy
Infiltrx
Irricure
Kinetic
Kinetic HV
Lawn Honey
Lesco Flo
Lesco Wet Plus

Lescoflo Ultra
Liberate
Logix
Magnus
Magnus
Matador
Matrixx
Mizer
Monsoon
Move

Myst
Naiad
New Balance
NoburN2
Oars
Oasis XL
Oasys
One-Putt
Optima
PAS 800

COMMON WETTING AGENTS

Peerless
Pen-a-trate
Penetrator Plus
Percolate
Pervade
Phase
Primer Select
Proforma Gold
Label
Pro-Mate
Pro-Mate Induce

Pro-Mate Kinetic
Pro-Mate Scatter
Quadra-Tek
Quark
Rapid Spread
Ready
Recover
Rely II
Respond 2
Respond 3

Retain Max
Retain Pro
Revolution
Rewet
Rivet
Scatter
Siffusion
Sil Energy
Sil Tek
Sil-Fact

COMMON WETTING AGENTS

Sil-Fact HV
Silkin
Sil-Mes 100
Silnet 200
Silwet L-77
Sixteen 90
Soaker
Sorba-Gro
Speed
Star Oil

Sun Energy
Sun Stream
SunEnergy
Surf
Surfactant pH
Surfside 37
Sur-Plus
Sylgard 309
Syl-Tac
Symphony

Syringe
Tactic
Tee Off
Tension Aid
Thoroughbred
Tournament Ready
Tricure
TriCure AD
TriCure Micro

COMMON WETTING AGENTS

Ultraflo

Advance

Ultraplex

Ultrawet

Vivax

Wet Foot

Widespread

Max

XL Fairway

Yuccah

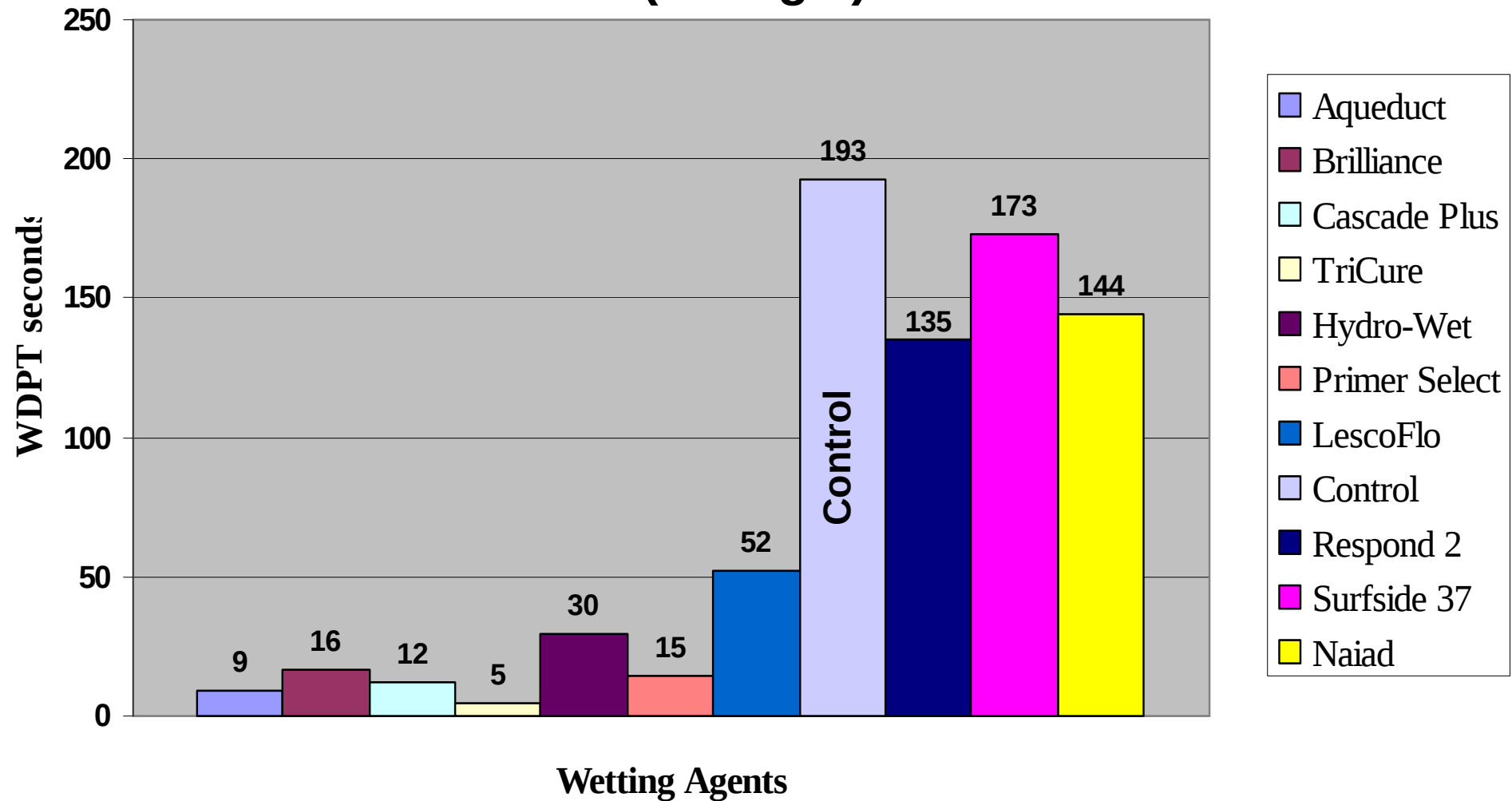
GCSAA/USGA WETTING AGENT STUDY

NINE LOCATIONS

2003 AND 2004



GCSAA Wetting Agent Study 2003/2004 WDPT (Georgia)



Primer vs. Revolution

TREATMENT	APP DATE	6/5 ²	6/12	7/3	7/31	8/28	9/25	10/23
Soil Water Repellency ³								
Primer	6/5, 7/3, 7/31	2.4a	0.9cd	1.8cde	1.2de	1.7cd	2.1a	2.1a
Revolution	6/5, 7/3, 7/31	2.4a	0.6de	1.5de	1.1e	1.4d	1.8a	2.1a
Control		2.4a	2.4a	2.5a	2.3a	2.3a	2.2a	2.2a

¹Irrigation – Immediate = Plots irrigated with 0.64 cm (0.25 in) of water immediately after treatment application

²Soil water repellency readings taken before initial treatment application

³Soil water repellency – 0.0 to 4.0 (0.0 = non-water repellent and 4.0 = extremely water repellent)

⁴Means in same column joined by the same letter are not significantly different at the 0.05 level of probability according to Duncan's Multiple Range Test

Revolution vs. Cascade

TREATMENT	APP DATE	6/5 ²	6/12	7/3	7/31	8/28	9/25	10/23
Soil Water Repellency ³								
Revolution	6/5, 7/3, 7/31	2.4a	0.6de	1.5de	1.1e	1.4d	1.8a	2.1a
Cascade	6/5, 6/15	2.2a	0.6de	1.5de	1.8bc	1.8bcd	2.1a	2.1a
Control		2.4a	2.4a	2.5a	2.3a	2.3a	2.2a	2.2a

¹Irrigation – Immediate = Plots irrigated with 0.64 cm (0.25 in) of water immediately after treatment application

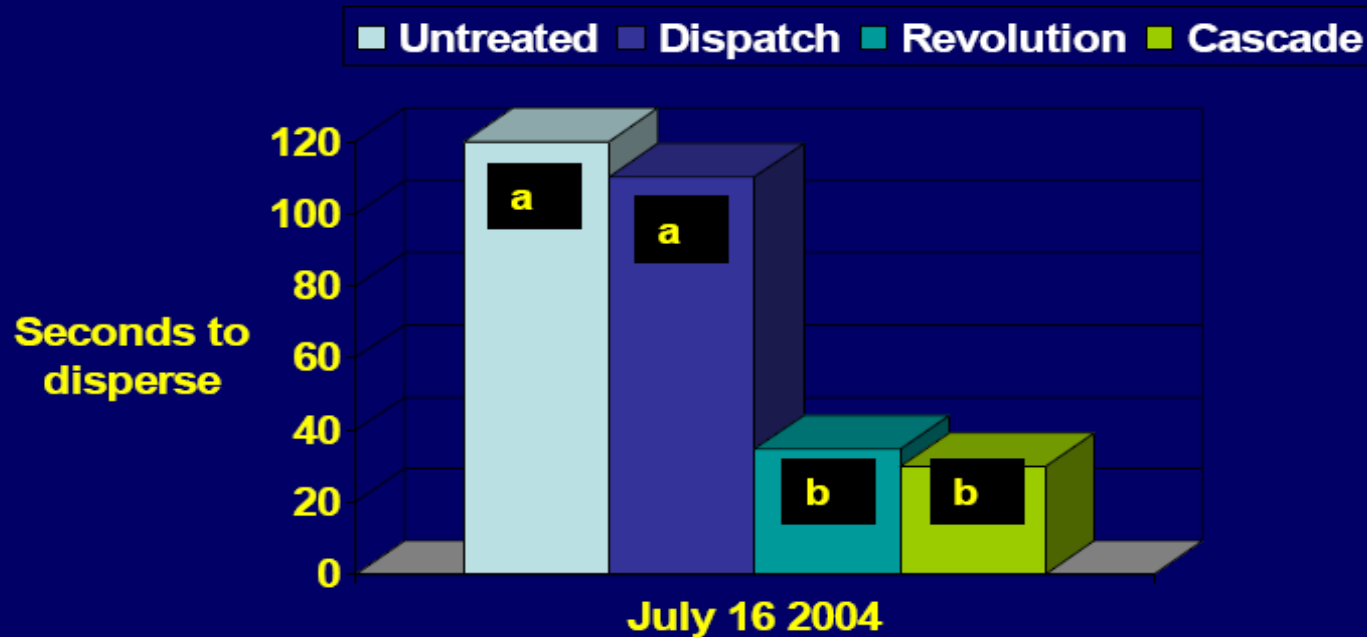
²Soil water repellency readings taken before initial treatment application

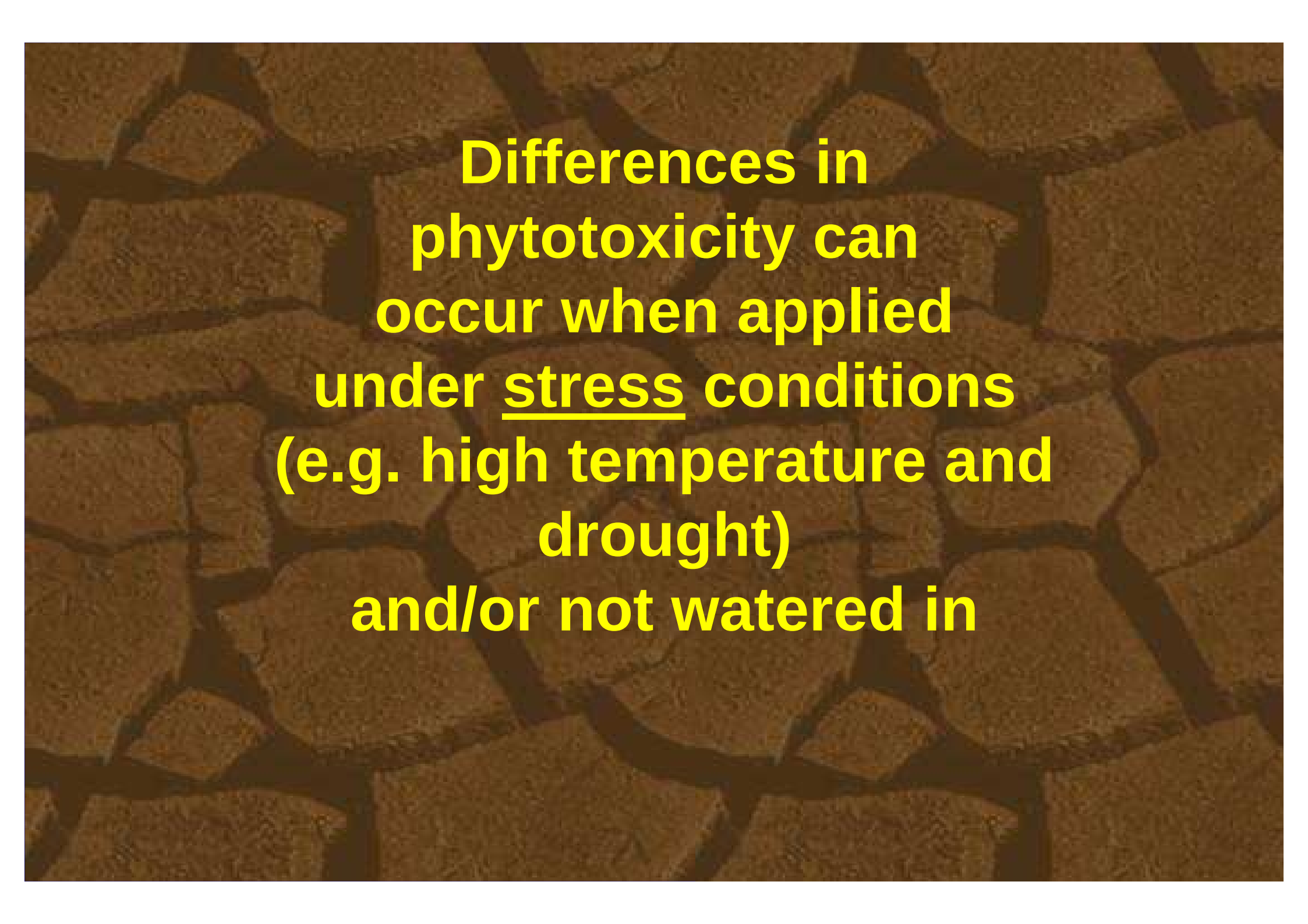
³Soil water repellency – 0.0 to 4.0 (0.0 = non-water repellent and 4.0 = extremely water repellent)

⁴Means in same column joined by the same letter are not significantly different at the 0.05 level of probability according to Duncan's Multiple Range Test

Confirming Hydrophobicity on bent green: 2004

Seconds required for water droplet penetration at thatch/soil interface



The background of the slide is a close-up photograph of a stone wall. The stones are irregular in shape and size, with a mix of brown, tan, and grey tones. The mortar between the stones is a dark, almost black color, creating a strong contrast with the lighter stones. The lighting is somewhat uneven, with brighter areas on the upper left and darker areas towards the bottom right.

**Differences in
phytotoxicity can
occur when applied
under stress conditions
(e.g. high temperature and
drought)
and/or not watered in**

**Rates,
number of
applications and cost
vary
dramatically
among products**

**Most effective product,
rate and number of
applications probably
depends on the site and
situation being treated.**

Other Considerations

- **Formulation**
- **Phytotoxicity**
- **Availability**
- **Duration of effectiveness (long vs. short)**
- **Cost**
- **Technical support from company**

TAKE HOME MESSAGE

#10

“Best wetting agent?”

**This is defined by the
needs of the end user.**



CURRENT QUESTIONS

(BEYOND WHICH IS BEST)

QUESTION

“Spot treat or treat the whole green?”

A photograph of a golf course green, showing distinct patterns of water repellency. The green is covered in grass, with some areas appearing lighter green or yellowish, indicating where water has not penetrated the soil. The text is overlaid on the image.

**REMEMBER -- degree of
soil water repellency
varies across green
(mild to severe)**



Depth (in.)		VWC	
0.5	—	8.0	18.0
1.5	—	1.3	15.8
2.5	—	2.0	3.9
3.5	—	1.2	1.0
4.5	—	1.0	0.9

**Results in variation of turfgrass growth (roots)
due to varying moisture (nutrients) and
temperature across area.**



No wetting agent

Depth (in.)	VWC	VWC
0.5	8.0	18.0
1.5	1.3	15.8
2.5	2.0	3.9
3.5	1.2	1.0
4.5	1.0	0.9

Wetting agent

Depth (in.)	VWC	VWC
0.5	15.1	12.3
1.5	17.0	16.5
2.5	6.6	9.9
3.5	2.5	3.8
4.5	1.4	1.2

TAKE HOME MESSAGE #11

“In most cases, a wetting agent should be applied across the entire green if water repellent soil is detected.”



QUESTION?

“I’ve been told that simply doubling the amount of a wetting agent will increase its performance (longevity and effectiveness). Is this true?”

SOIL WATER REPELLENCY At VARYING RATES OF A WETTING AGENT

<u>Trt. Rate</u>	<u>5/28</u>	<u>6/11</u>	<u>6/25</u>	<u>7/9</u>	<u>7/23</u>
	<u>Water repellency value*</u>				
WA 6 oz	2.9a**	1.6b	2.1b	1.4b	1.3b
WA 10 oz	2.9a	1.4b	1.9b	1.4b	1.3b
WA 12 oz	3.1a	0.0c	0.9c	0.6c	0.8b
WA 12/12 oz	2.9a	0.9c	0.4c	0.8c	1.2b
<u>Control</u>	<u>2.9a</u>	<u>2.8a</u>	<u>2.9a</u>	<u>2.7a</u>	<u>2.8a</u>

*Water repellency value: 0= none, 4.0=severe

**Pre-application

TAKE HOME MESSAGE

#12

- Increasing the rate of a wetting agent will not necessarily increase its performance.



QUESTION?

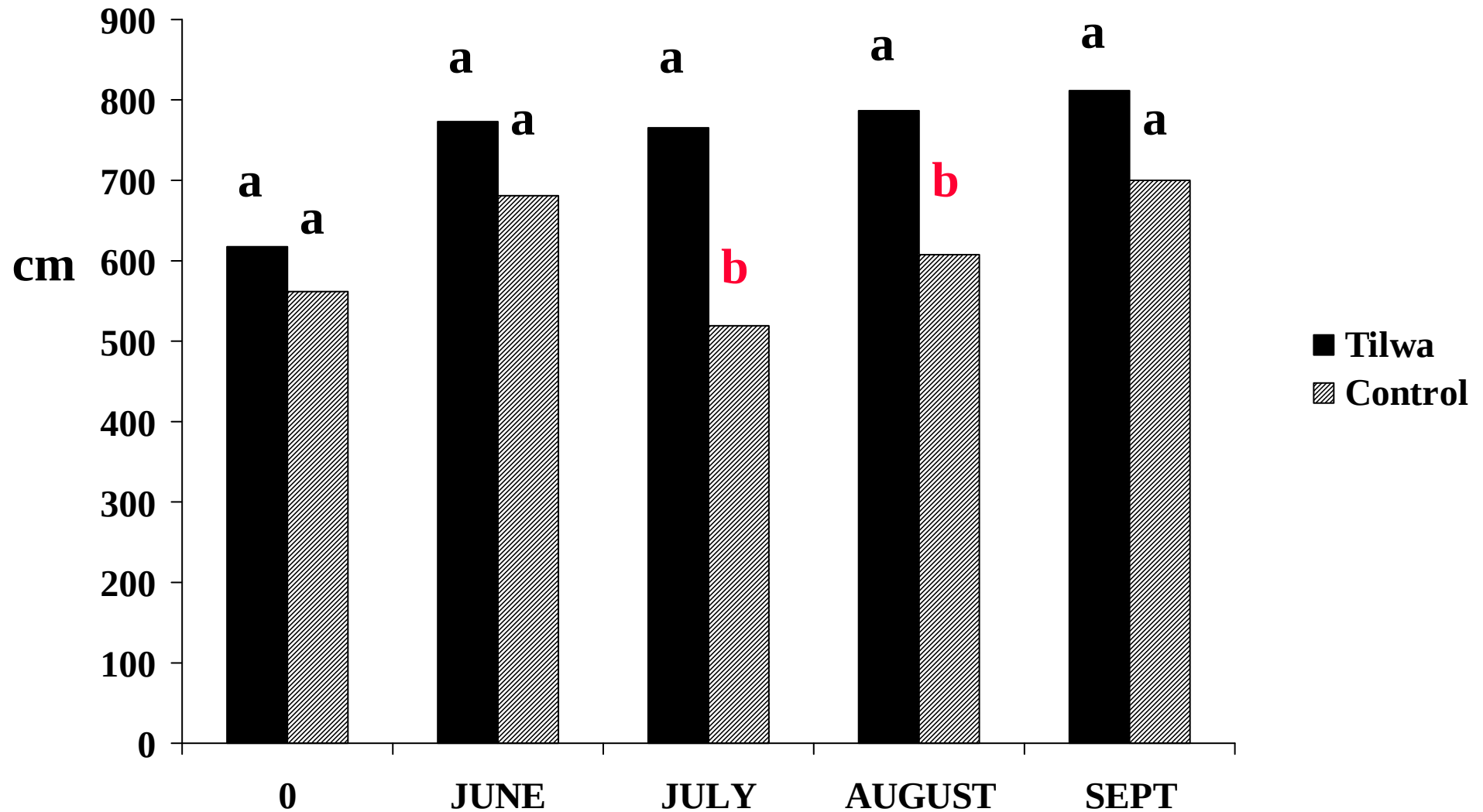
“Do wetting agents help or hurt turfgrass roots?”

- **Early research with older products did report negative effects on root growth.**

Remember...

In a putting green situation, the majority of the root system is often in the top 2 inches. Same zone as water repellent soil.

TOTAL ROOT LENGTH AFFECTED BY TILWA (SIMILAR RESULTS SEEN WITH LESCOFLO)



TAKE HOME MESSAGE

#13

- Under water repellent soil conditions, the use of a wetting agent may improve root growth and survival.



QUESTION?

- Is one formulation better than another (liquid versus dry)?
- Our experience has shown that in most cases if the same amount of active ingredient is applied and label instructions followed, liquid and dry formulations work similarly. (must get into the soil)

TAKE HOME MESSAGE

#14

- In *most* cases, wetting agent performance is not dependent on formulation (dry vs. liquid).

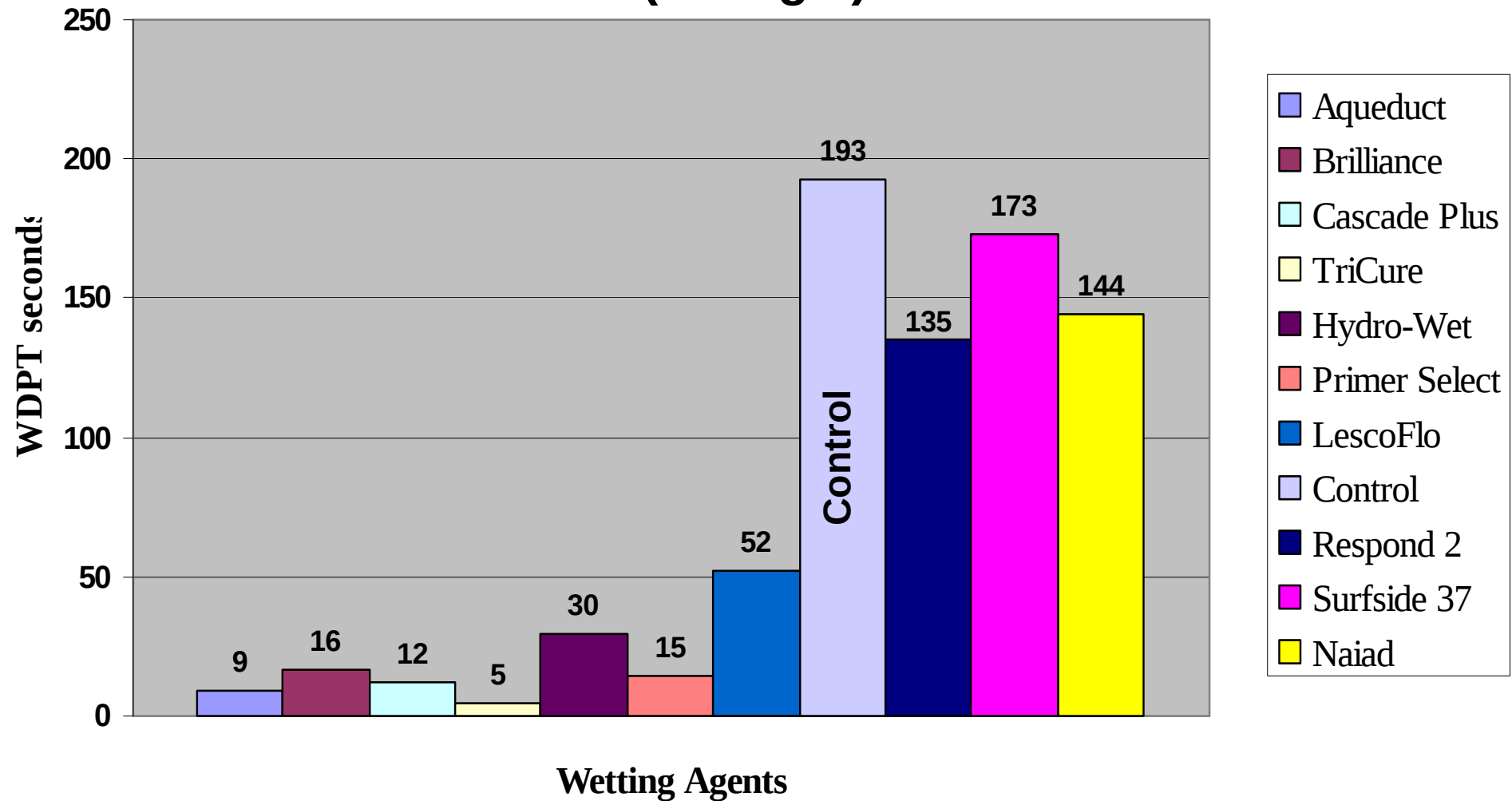


QUESTION?

“In terms of overall performance, how much difference is there among wetting agents in terms of. . .

- 1. Longevity of performance**
- 2. Effectiveness in lowering the degree of water repellency?”**

GCSAA Wetting Agent Study 2003/2004 WDPT (Georgia)



Yuccah Wetting Agent and Soil Water Repellency

<u>Treatment</u>	<u>6/1</u>	<u>6/8</u>	<u>7/1</u>	<u>7/9</u>	<u>7/30</u>	<u>8/26</u>
	<u>Water repellency value*</u>					
Yuccah 6 oz	2.5a**	1.6b	2.0a	1.7b	2.2a	2.3a
<u>Control</u>	<u>2.4a</u>	<u>2.2a</u>	<u>2.2a</u>	<u>2.2a</u>	<u>2.3a</u>	<u>2.3a</u>

*Water repellency value: 0= no repellency, 4= severe repellency

**Pre-application

Lescoflo and Soil Water Repellency

<u>Treatment</u>	<u>6/17</u>	<u>7/16</u>	<u>8/16</u>	<u>9/15</u>	<u>10/15</u>	<u>11/15</u>
	<u>Water repellency value*</u>					

Lescoflo 16 oz	2.3a**	0.0a	0.9a	1.3a	1.7a	2.3a
----------------	--------	------	------	------	------	------

<u>Control</u>	<u>2.5a</u>	<u>2.8b</u>	<u>2.8b</u>	<u>2.7b</u>	<u>2.4b</u>	<u>2.6a</u>
----------------	-------------	-------------	-------------	-------------	-------------	-------------

*Water repellency value: 0= no repellency, 4= severe repellency

** Pre-application

Cascade and Soil Water Repellency

<u>Treatment</u>	<u>7/10</u>	<u>7/17</u>	<u>7/25</u>	<u>8/14</u>	<u>8/27</u>	<u>10/10</u>
	<u>Water repellency value*</u>					
Cascade 16 oz	2.2a**	0.0b	0.3b	0.8b	1.1b	1.5b
<u>Control</u>	<u>2.1a</u>	<u>2.1a</u>	<u>2.0a</u>	<u>2.2a</u>	<u>2.2a</u>	<u>2.3a</u>

*Water repellency value: 0= no repellency, 4= severe repellency

** Pre-application

TAKE HOME MESSAGE

#15

- There can be a significant difference among wetting agents in terms of longevity and ability to reduce soil water repellency.

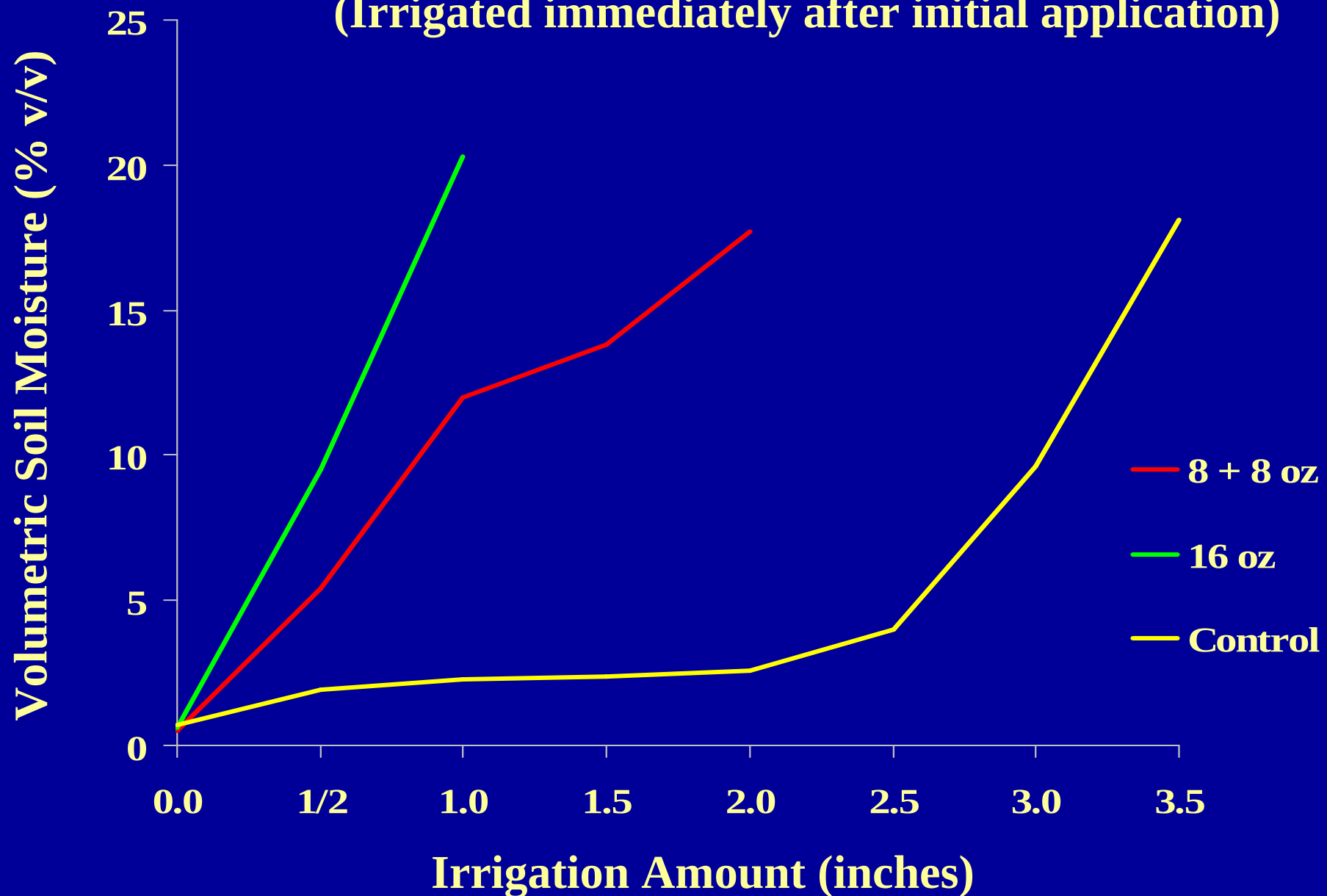


QUESTION?

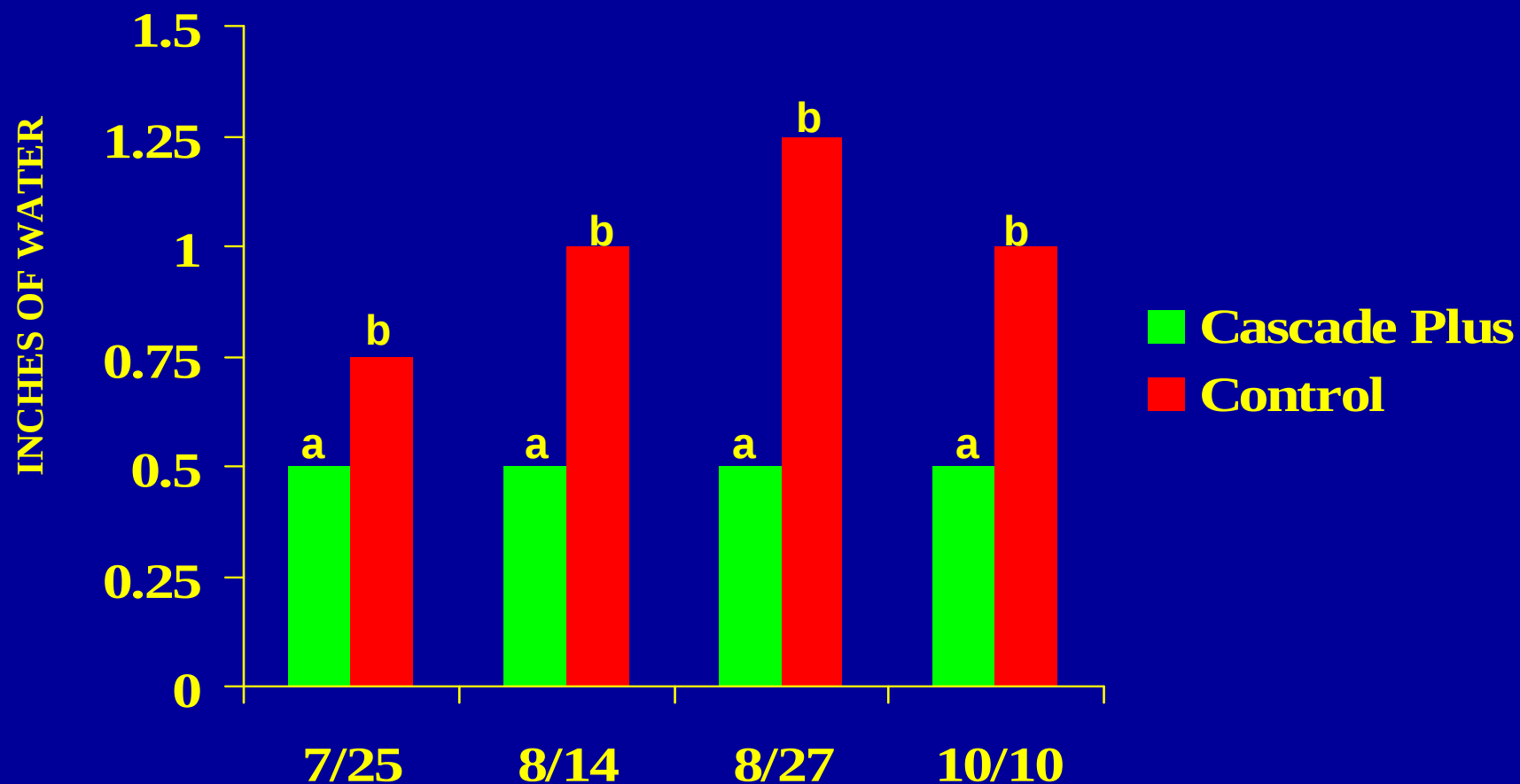
**“Can wetting agents improve
irrigation efficiency?”**

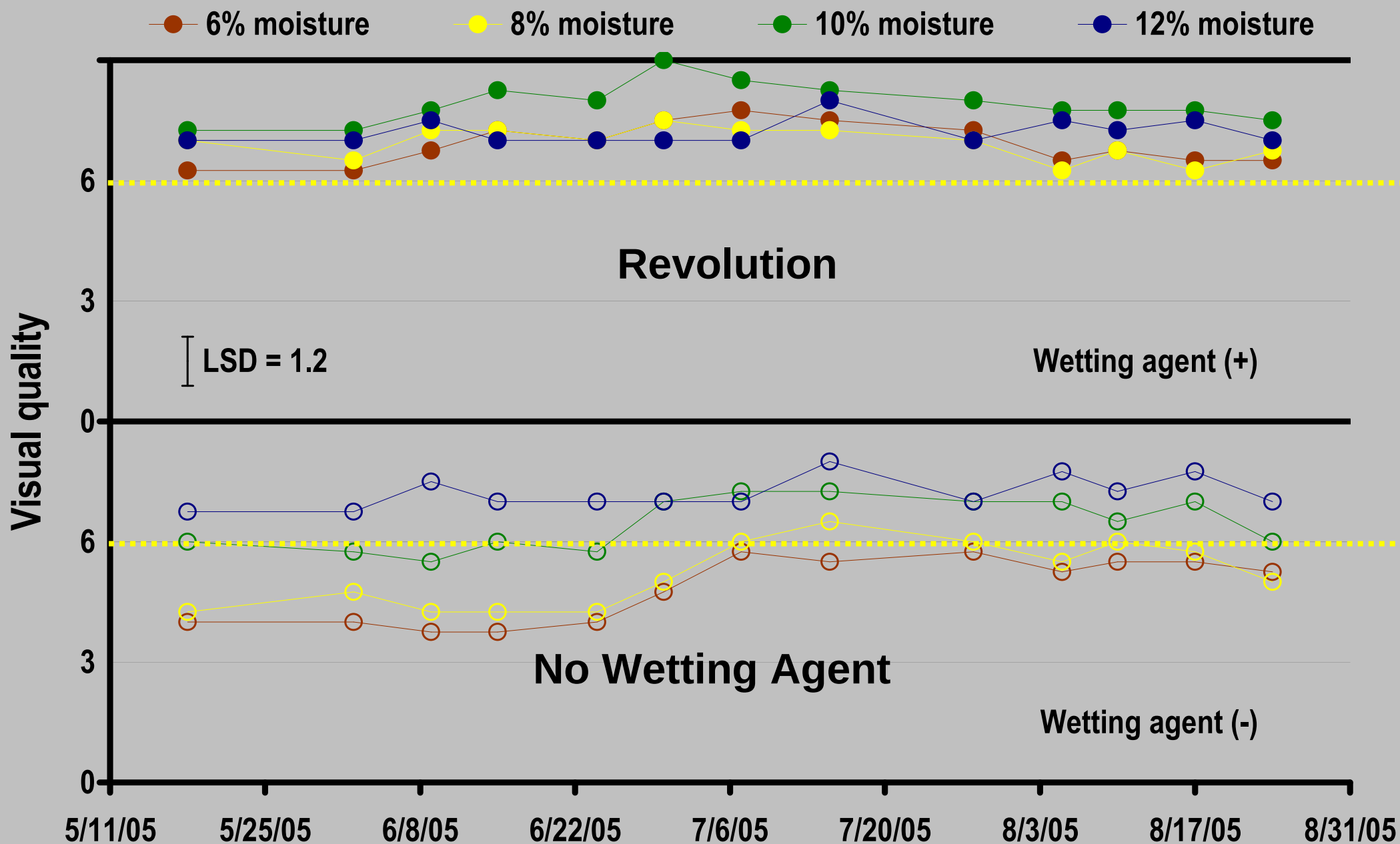
(save water)

Soil moisture as affected by a wetting agent (Irrigated immediately after initial application)



**Amount of irrigation water needed to raise soil moisture
from approximately 5% to 15% on a Crenshaw green.
(Two year field study)**





TAKE HOME MESSAGE #16

“Wetting agents applied to water repellent soil may result in increased water savings.”



QUESTION?

“Do some wetting agents hold moisture in the surface of the profile?”

SURFACE SOIL MOISTURE CONTENT OF *WATER REPELLENT* SOIL TREATED WITH VARIOUS WETTING AGENTS

TREATMENT	DAYS AFTER TREATMENT					
	0	1	2	3	4	6
-----PERCENT MOISTURE TOP INCH-----						
PRIMER	22.6a	15.4a	13.1a	11.9a	8.9b	7.4b
AQUEDUCT	23.9a	16.5a	13.2a	10.4a	9.4ab	7.5b
CASCADE	23.1a	15.4a	14.8a	12.2a	9.7ab	6.7b
CONTROL	24.1a	16.9a	13.5a	13.4a	10.8a	9.1a



**Influence of thatch/mat
and/or soil organic
matter content**

MOISTURE CONTENT OF 1 INCH THATCH/MAT LAYER TREATED WITH VARIOUS WETTING AGENTS

TREATMENT	DAYS AFTER TREATMENT					
	0	2	8	12	16	23
-----PERCENT MOISTURE TOP 1/2 INCH-----						
BRILLIANCE	33.1a	28.5ab	27.3ab	24.5ab	20.6a	8.4a
PRIMER	32.3a	25.5b	24.2b	22.1b	18.0a	8.1a
AQUEDUCT	33.9a	30.1a	28.1a	26.7a	19.6a	7.6a
CASCADE	33.3a	28.5ab	28.4a	26.3a	22.6a	10.9a
CTL WITH TH	30.8a	21.5c	18.7c	14.7c	9.0b	1.5b
CTL W/O TH	27.0b	10.7d	6.7d	4.7d	3.1c	0.2b

AMOUNT AND TYPE OF ORGANIC MATTER MAY AFFECT WETTING AGENT PERFORMANCE



CONCLUSION

Soil organic matter content exceeding **3.5** percent may dry down slower when treated with a wetting agent.

TAKE HOME MESSAGE #17

“Thatch/mat and/or high organic matter root zones may tend to dry out slower when treated with a wetting agent.”



QUESTION

**IS THERE AN ADVANTAGE TO APPLYING A
WETTING AGENT TO A NON-WATER
REPELLENT SOIL OR SAND BASED
ROOTZONE?**

VIDEO (Non-Water Repellent Sand)



SOIL MOISTURE CONTENT OF NON-WATER REPELLENT SAND BASED ROOTZONE TREATED WITH VARIOUS WETTING AGENTS

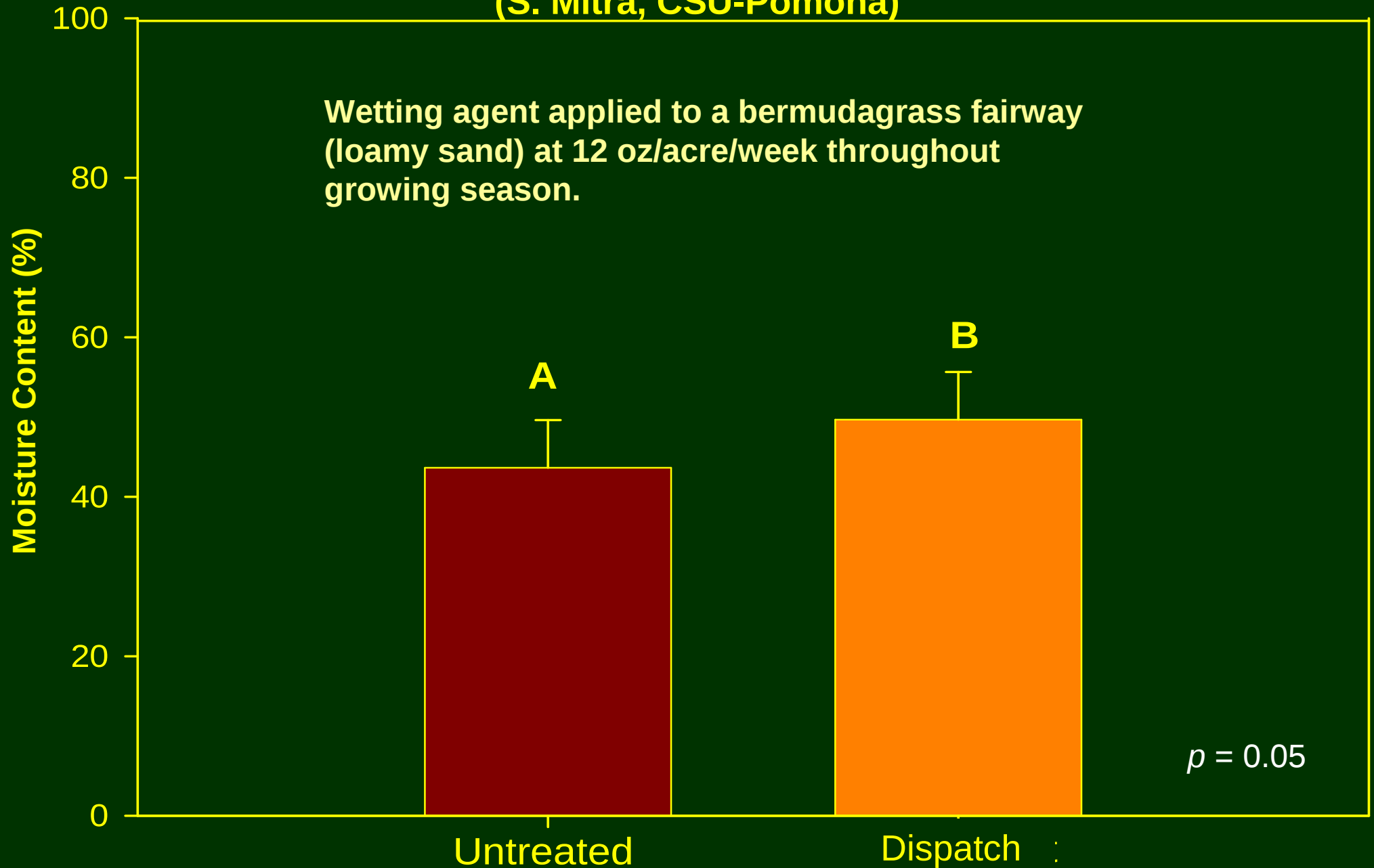
TREATMENT	DAYS AFTER TREATMENT					
	0	1	2	3	4	6
	-----PERCENT MOISTURE TOP INCH-----					
PRIMER	19.1a	10.4c	8.5c	7.5c	6.0c	4.1bc
AQUEDUCT	20.1a	12.3b	10.2b	9.0b	7.6b	4.8b
CASCADE	19.2a	9.4c	7.3c	7.1c	4.7d	3.6c
CONTROL	20.3a	15.2a	13.9a	12.0a	10.5a	8.1a



- **Non-Water Repellent (Finer Texture)
Fairway Turf.**

Volumetric Moisture Content from 2003, 2004 and 2005 (S. Mitra, CSU-Pomona)

Wetting agent applied to a bermudagrass fairway
(loamy sand) at 12 oz/acre/week throughout
growing season.



Volumetric soil water content of **non-water repellent** Cecil loamy sand as affected by Duplex and Magnus wetting agents (Tifway bermudagrass)

	8/21	8/21	8/26	9/23	10/1	10/7
	-----Percent Soil Moisture -----					
• Magnus – 4oz/1000sq ft	6.1a	17.7a	10.3a	24.7a	16.8a	23.1a
• Duplex – 1oz/1000sq ft	5.9a	8.7b	5.2b	25.7a	17.4a	23.0a
• Magnus + Duplex – 4 & 1	6.1a	16.7a	9.4a	25.3a	17.8a	23.4a
• Control	5.8a	9.1b	6.4b	25.2a	17.5a	22.4a
•						

- On 8/21 turf was irrigated with 1/8 inch of water. Then soil moisture content was determined.
- Turf color and quality were significantly improved for the Magnus treatments during 8/21 - 8/26 compared to the Duplex treatment and Control.

TAKE HOME MESSAGE

#18

The advantages of applying wetting agents to non water repellent soil remain unclear. Some research indicates “no value” other research suggests there is value. Apparently, it depends on the situation.

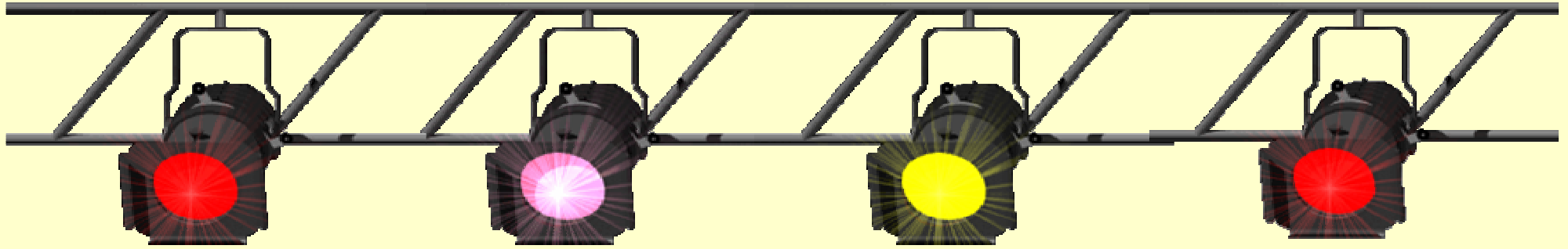


QUESTION?

“Can a wetting agent help move salts out of the root zone?”

ANSWER

Yes, if the soil is water repellent and there is subsurface drainage.



THANK YOU !



FINAL TAKE HOME

MESSAGE # 19