golf industry show

GCSAA Education Conference | Trade Show | GCSAA Golf Championships
San Diego Convention Center | February 6-11, 2016

EVERYTHING UNDER THE SUN

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GCBAA USGA NGF

A quick word on rolling, which some (not me) might consider a cultural control itself. I've had it suggested to me that rolling greens is a form of cultural control. I get the concept, but I don't agree. To me, a cultural control should be something done that physically improves the health of the turfgrass. Rolling does not benefit health. It benefits playability, at least in the short term.

I'm not knocking the concept of rolling. We roll once a week. Like I said, it improves the playability of the greens. But I can't get myself to consider it a cultural control, even when being done in place of a mow. Mowing, in my experience, is less stressful on golf course greens than rolling is.

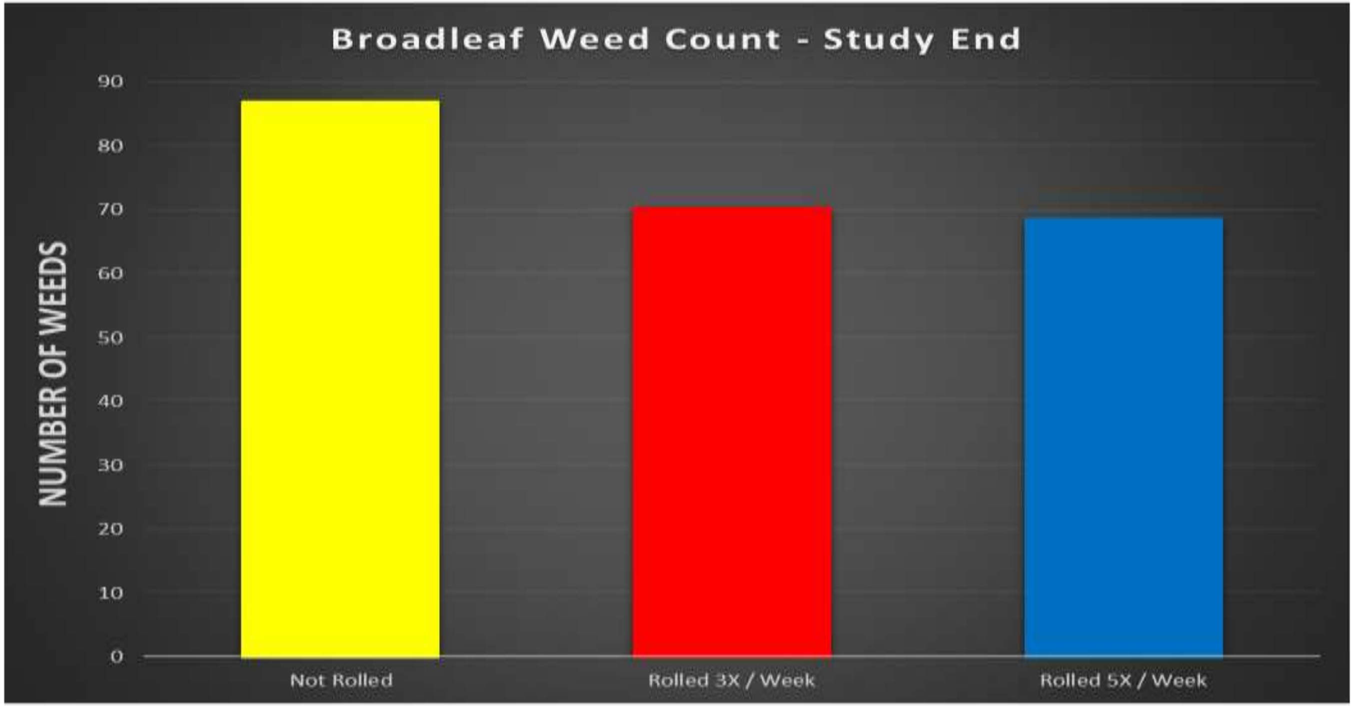
TOP 10 REASONS TO ROLL GOLF GREENS

10. Alleviate frost heaving
9. Seed bed preparation
8. Broadleaf weed, moss, & algae reduction
7. Decreased localized dry spot
6. HOC can be raised and green speeds retained resulting in an increase in wear tolerance and a decrease in brown patch and anthracnose.
5. Decreased localized dry spot
4. Better topdressing incorporation
3. Decreased dollar spot
2. The Economy
1. Increased customer satisfaction

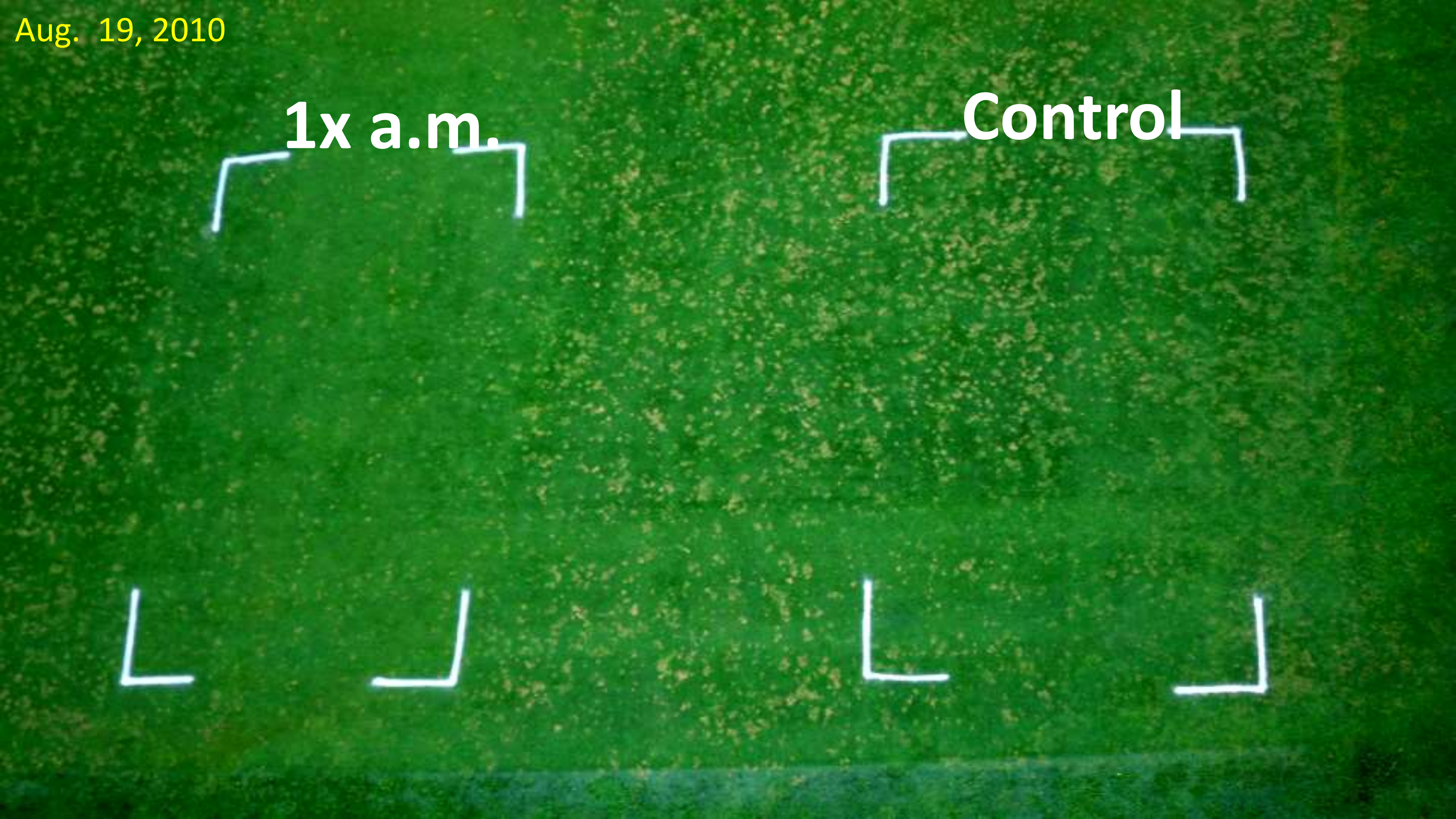
Fairway rolling? Really?

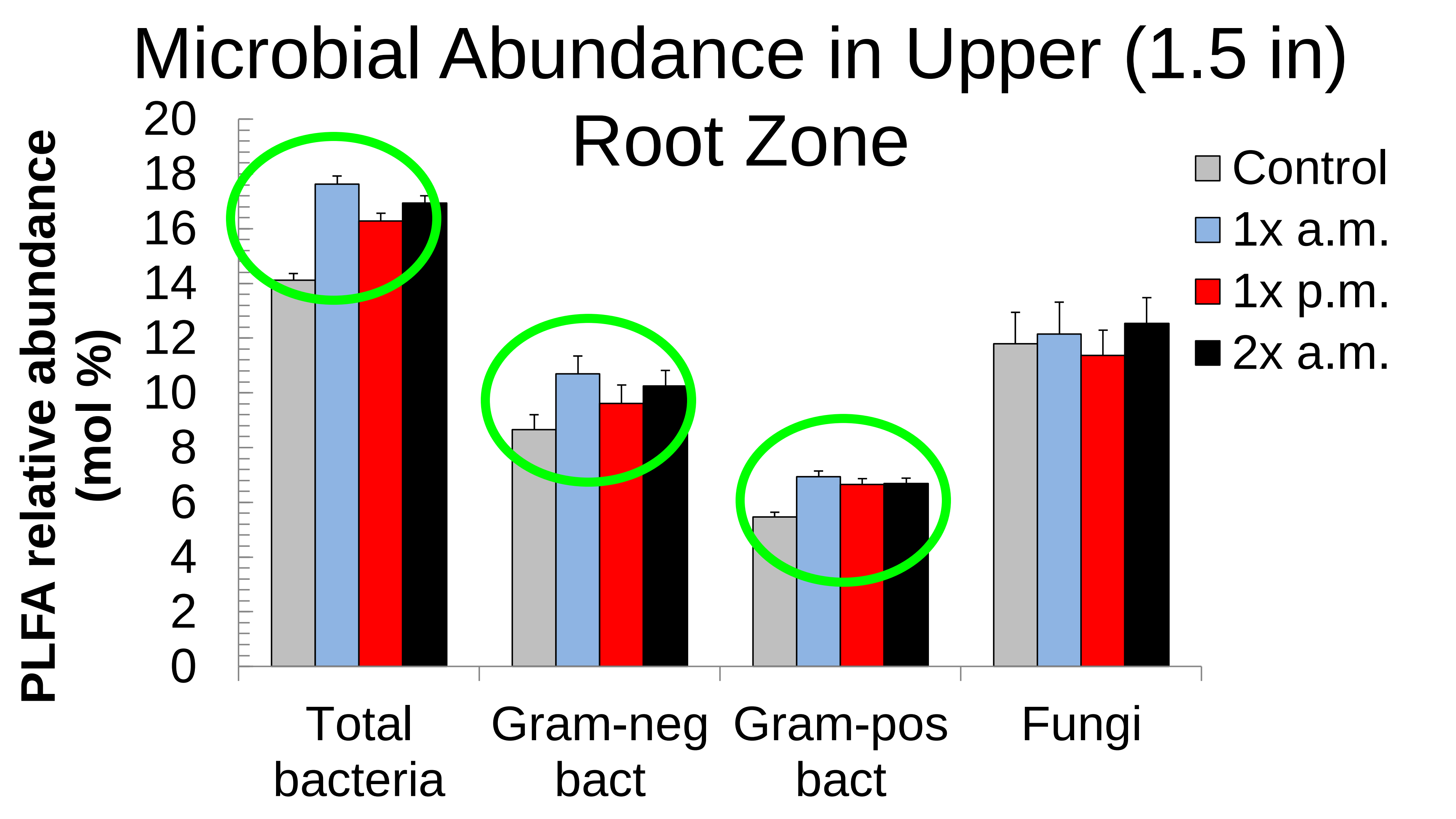
Lawn Height Weed/rolling study 2015

RESULTS



Broadleaf Weed Count - Study End
90
80
70
60
50
40
30
20
10
0
NUMBER OF WEEDS
Not Rolled
Rolled 3X / Week
Rolled 5X / Week


Aug. 19, 2010
1x a.m.
Control

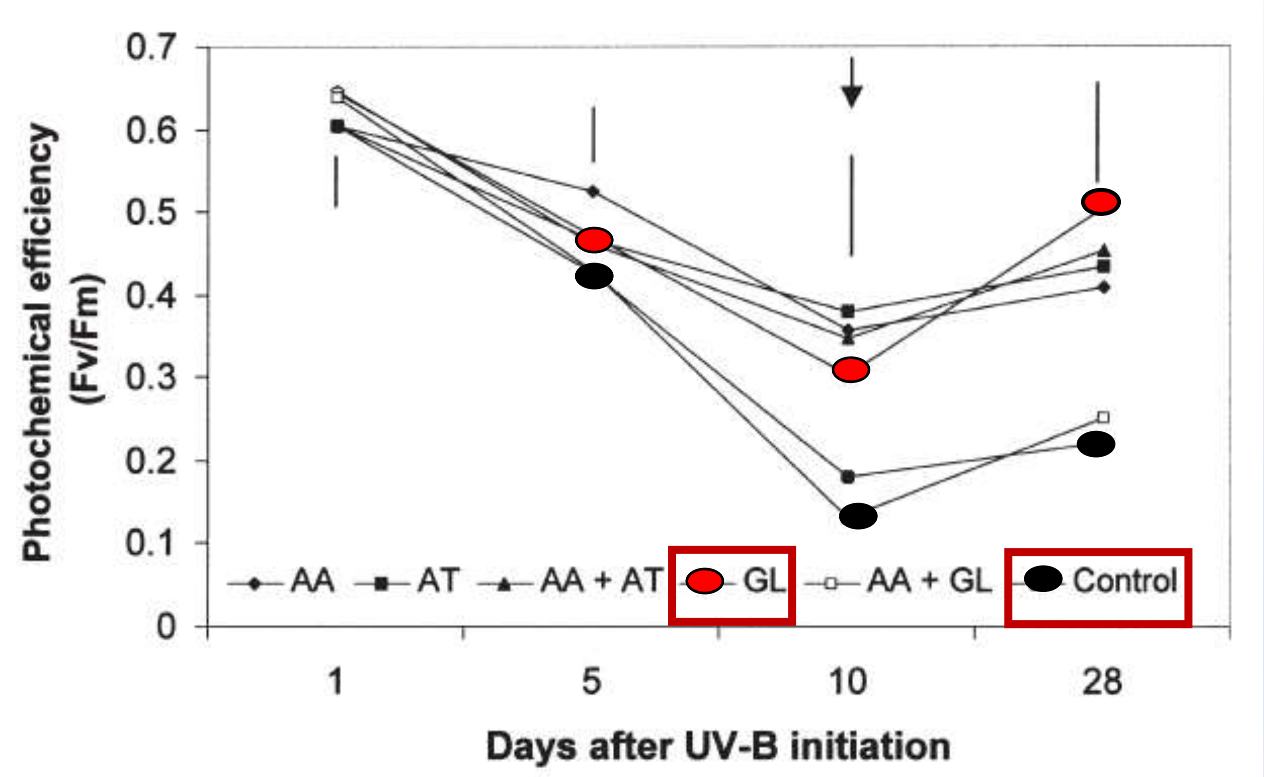


Microbial Abundance in Upper (1.5 in) Root Zone
PLFA relative abundance (mol %)
20
18
16
14
12
10
8
6
4
2
0
Control
1x a.m.
1x p.m.
2x a.m.
Total bacteria
Gram-neg bact
Gram-pos bact
Fungi

Numerous commercially available pigments

TURF SCREEN™
Enhanced Solar Protection™

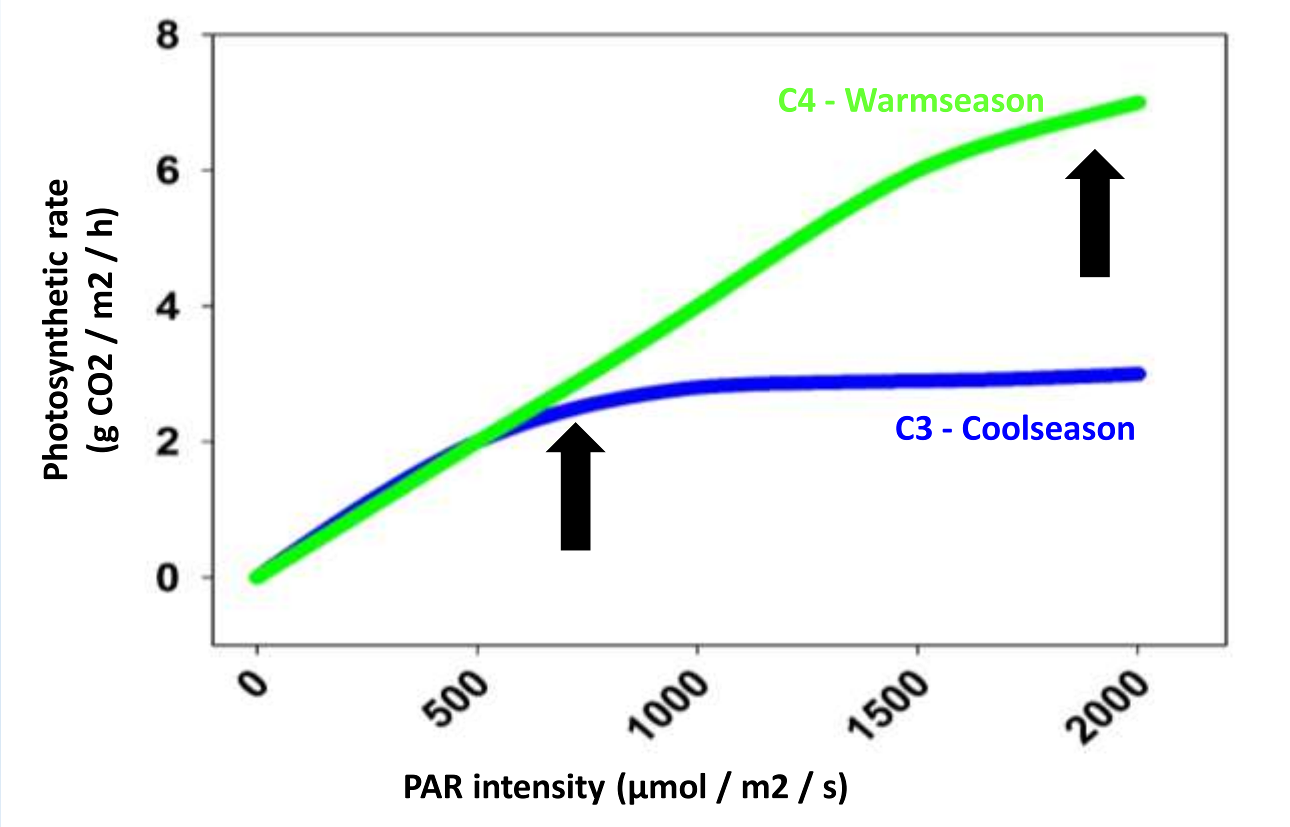
Pigment effect on photosynthetic efficiency under UV-B stress



Ervin, et. al., 2004. HortScience

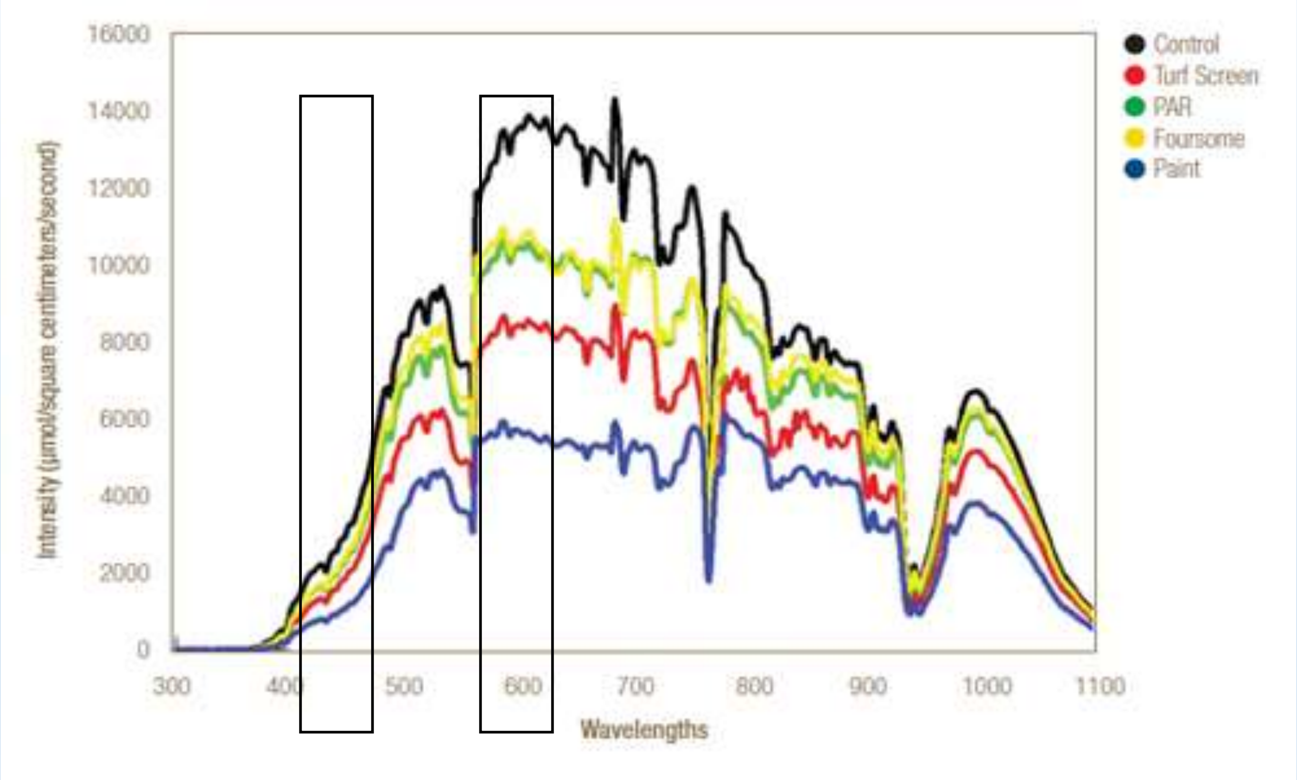
Photosynthetic response of C3 and C4 grasses to light

Full sunlight = ~2000 µmol/m2/s

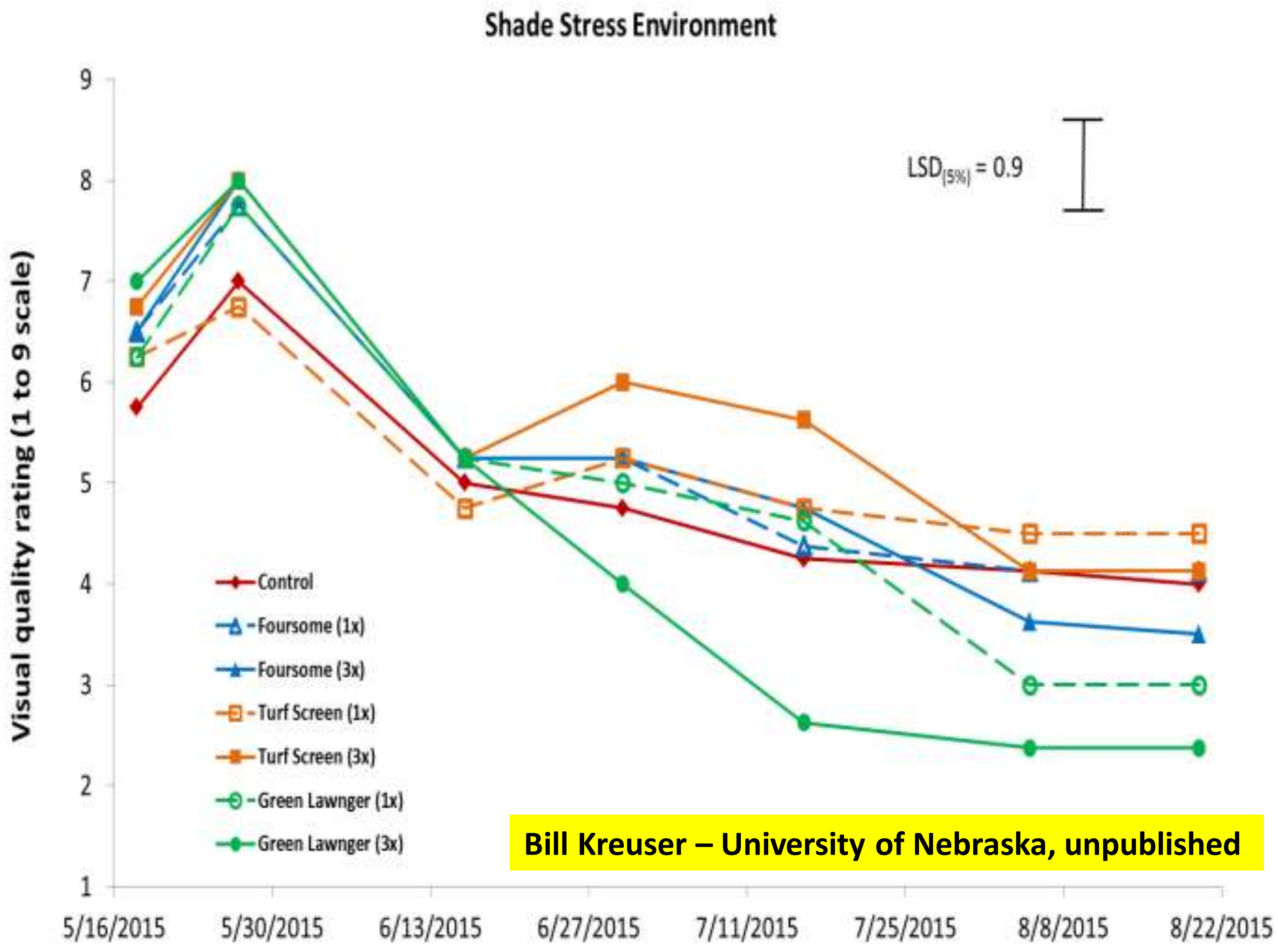


Pigments Reduce Light Quantity

Light Transmission

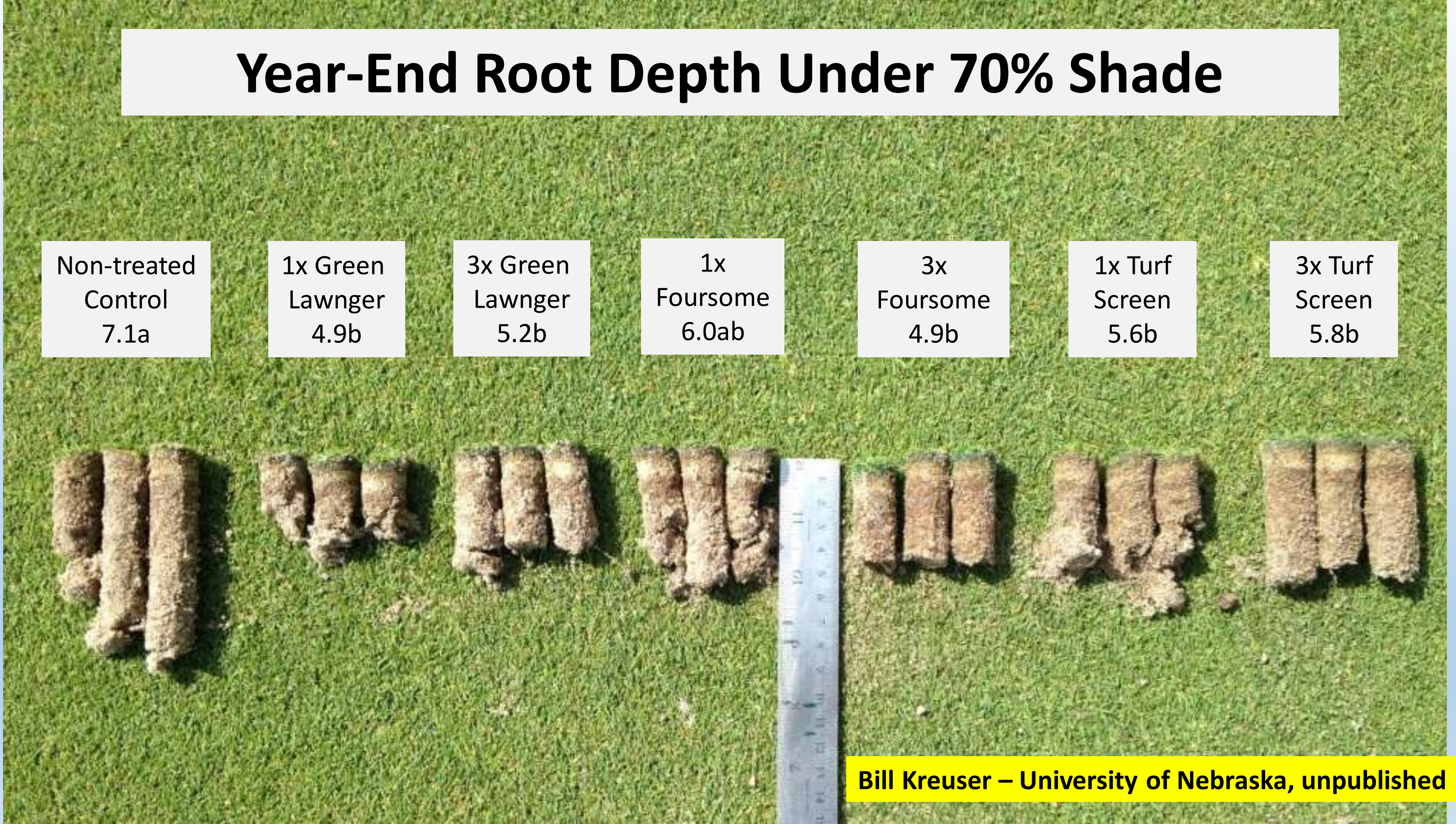


McCarty, Gore, and Gann, 2014. GCM

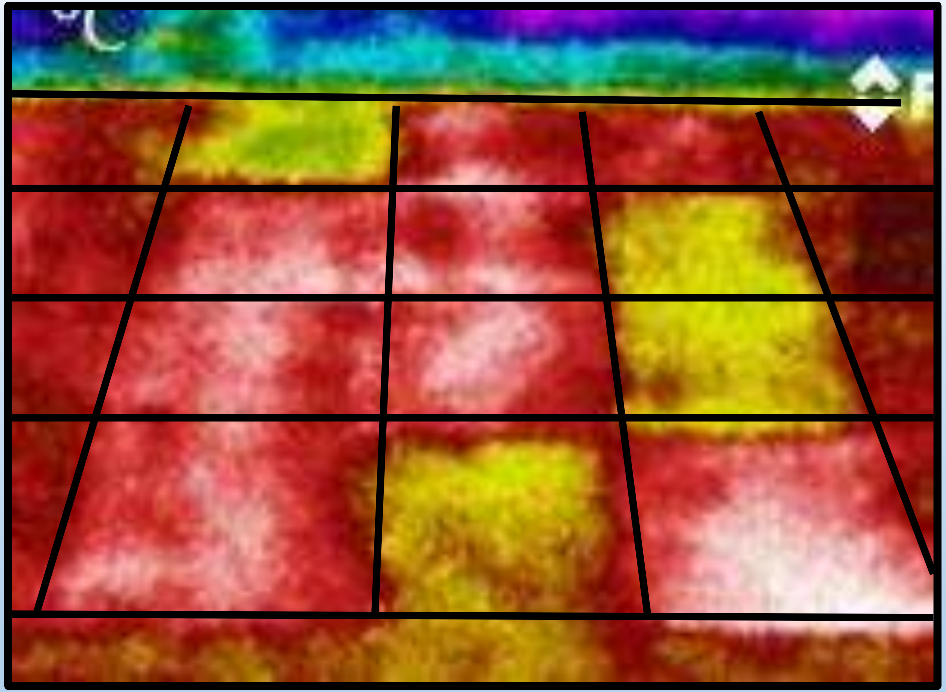


Bill Kreuser – University of Nebraska, unpublished

Year-End Root Depth Under 70% Shade



Surface Temperature Increased 1-6°F



Treatment	°C
Civitas + Harmonizer	30.3a
Civitas +2x Harmonizer	30.3a
Civitas Alone	30.1b
Harmonizer	29.8c
Control	29.4d

Largest Temperature Increase Immediately After App

Bill Kreuser – University of Nebraska, unpublished

Do pigments enhance turfgrass health??

- **Pros**
  - **Can protect cool-season grasses from UV radiation**
- **Possible Cons**
  - **Can increase canopy temperature**
  - **May increase shade stress**

Take-home thoughts…

- **Some pigments block more light than others**
  - **Winter colorants block more light than UV blockers**
- **Pigments could accelerate shade problems, especially on shade-sensitive warm-season grasses**
- **Don't increase heat-stress problems in cool-season grasses**

What Do We Mean by That?

- Want a measurement of all the microbial organisms in the soil.
- Measurement methods vary and are always changing.
- Chloroform extraction – total microbial biomass.

Recognize the Difference Between Short- and Long-Term Effects

Soil microbial biomass (µg C per g soil) of hybrid bermudagrass as affected by N source, 27 July 2010, Auburn, AL.

Applied at 1 pound N 1,000 ft^{-2} to hybrid bermudagrass fairway.

N SOURCE	µg C per g soil
Urea (46-0-0)	171.6 a
Milorganite (6-2-0)	217.0 a
Nature Safe Starter (5-6-6)	154.4 a
Nature Safe Stress Guard (8-3-5)	241.8 a
Sustane (4-6-4)	222.4 a
Top Organic Fertilizer Fine Grade (4-2-2)	217.3 a
Top Organic Fertilizer Regular Grade (4-2-2)	210.0 a
Sustane (8-2-4)	181.7 a
Scotts Turf Builder (32-0-10)	214.4 a
No fertilizer	180.4 a

Short Term Results – Others

- Tifdwarf.
- Eco (dehydrated alfalfa, sunflower seed hull ash, bone, blood, canola and soybean meal) Sustane (turkey feather litter), Ringer (poultry feather meal, wheat germ, soybean meal), Milorganite (biosolid).
- IBDU.
- Applied every 2 weeks at an N rate of ¾ lb N/1,000 sq. ft.
- bacteria and fungi counts.

(Elliott and Des Jardin, 1999)

Effect of Organic Fertilizers on Microbial Populations

Material	Bacillus	Total fungi	Actino.	Total bacteria
	Log$_{10}$ cfu per g material			
Eco	6.21 a	4.64 a	4.55 a	6.80 a
Milorg.	6.10 a	4.67 a	4.54 a	6.82 a
Ringer	6.20 a	4.61 a	4.58 a	6.75 a
Sustane	6.11 a	4.67 a	4.45 a	6.82 a
IBDU	6.26 a	4.60 a	4.56 a	6.84 a
(Top.	4.33	5.13	2.90	6.30)

(Elliott and Des Jardin, 1999)

Long-term Application of Organic fertilizers will build your soil microbial pool.

- KY Bluegrass – 15 years of fertilization
- Organic fertilizer, urea or inorganic (98, 171 or 245 kg N ha^{-1} yr^{-1}) (~87, 152, 218 lb N/A) (2, 3.5 or 5 lb N 1,000 ft^{-2}).
- Measured nematodes (types and community structure), total microbial biomass, and various N forms.
- +/- herbicides (pendimethalin/2,4-D, dicamba, MCPA), +/- fungicide (triadimefon), +/- insecticide (diazinon)

Cheng et al., 2008

The Results

	N rate	Control, organic, mineral	No herbicide vs herbicide	No insecticide vs insecticide	No fungicide vs fungicide
	p-value				
Organic N	0.06	0.71	0.63	0.19	0.83
Microbial biomass N	0.21	0.0001	0.59	0.51	0.17

Let’s take a closer look at that....

	Microbial biomass N (ppm)	Soil organic matter (%)
Control	104 c	4.51 b
Organic (216)	134 a	4.95 a
Organic (216) + post-herb	128 ab	4.55 b
Mineral (219)	106 c	4.44 b
Mineral (98) + pre/post herb	100 c	4.37 b
Mineral (245) + pre/post herb + fung	110 c	4.63 b
Mineral (171) + pre/post herb + insect	107 c	4.63 b

October, 2004 data collection

After 15 years application of organic fertilizers resulted in a significantly higher soil microbial biomass.

Grass blades have turned purple on USGA root zones in 2013 from certain treatments

Common nutrient sufficiency range for turfgrass tissue testing

• **Nitrogen**	**2.8-3.5%**
• **Phosphorus**	**0.2-0.5%**
• **Potassium**	**1.5-3.0%**

Fertilizer carrier effect nutrient content

June 16, 2013

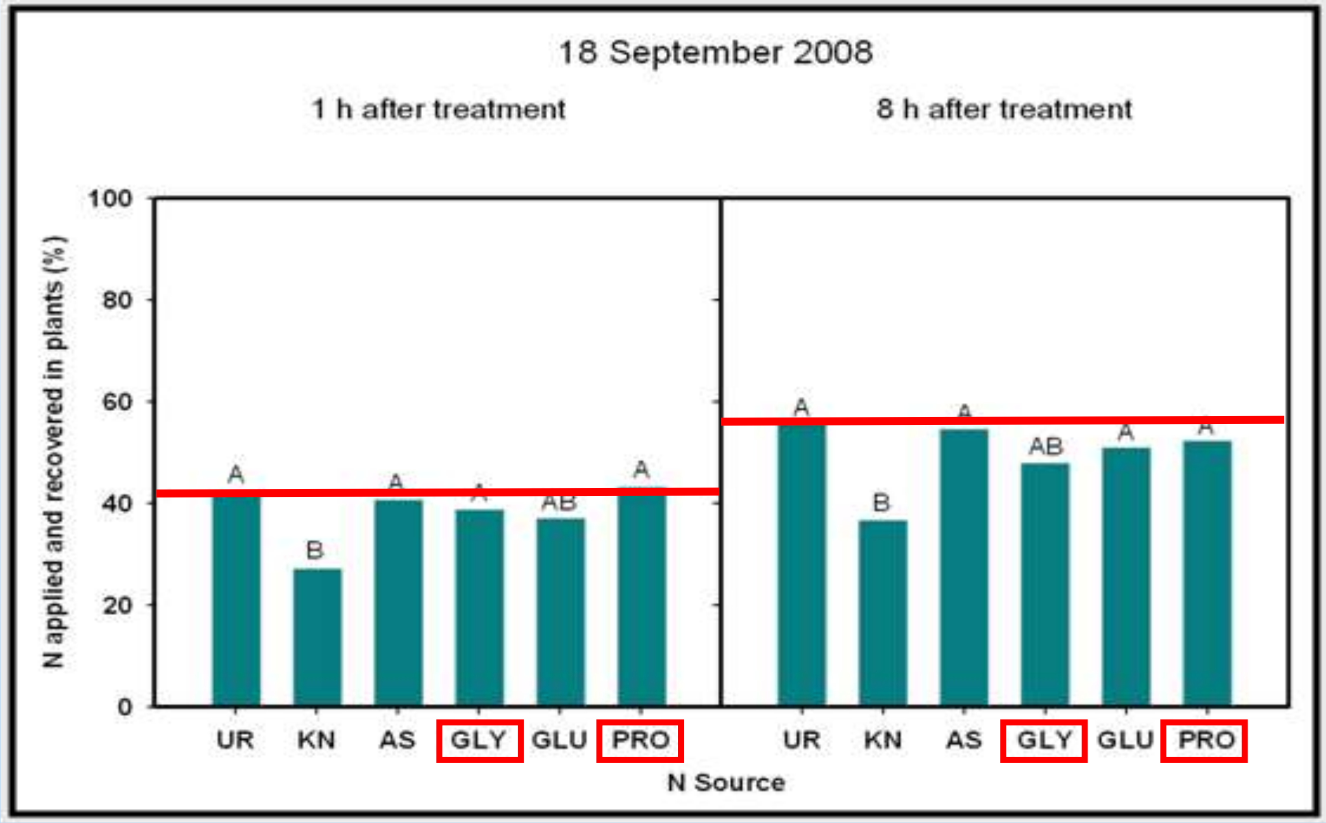
	Soil P ppm	Soil K ppm		Tissue N	Tissue P	Tissue K
Check	5.5 ab	22 bc		2.1 d	.2 d	.8 d
Organic	4.2 bcd	29 a		3.8 ab	.4 bc	1.6 ab
MU	3.7 cd	19 c		2.7 c	.2 d	1.1 c
Urea	3.2 d	22 bc		3.7 b	.2 d	1.5 b
Urea + P	5.7 a	21 c		3.6 b	.5 a	1.5 b
Urea + K	3.8 cd	22 bc		3.7 b	.2 d	1.6 b
Fol + Gran	4.8 abc	26 ab		4.1 a	.5 a	1.8 a
Folier	5.5 ab	22 bc		3.5 b	.4 bc	1.5 b

Letters in columns indicate difference among fertilizer treatments (P=0.05).

Do foliar applications of amino acids affect plant health?

- Common component of liquid fertilizers
- If foliar applied, the plant does not have to expend energy to make AAs
- Are they are a better source of N than urea or NO_3 or NH_4?
- Data on turfgrasses are minimal…

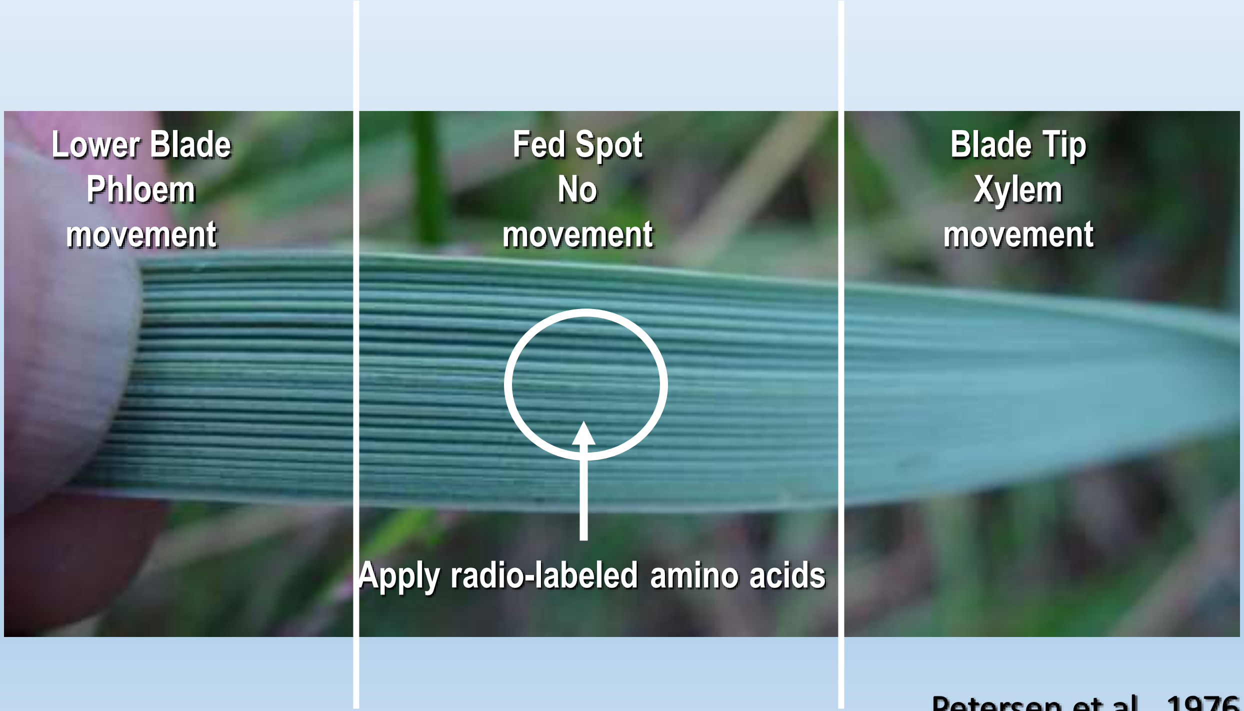
Foliar N Source Uptake Study



CODE	N source
UR	Urea
KN	Potassium nitrate
AS	Ammonium sulfate
GLY	Glycine
GLU	Glutamic Acid
PRO	Proline

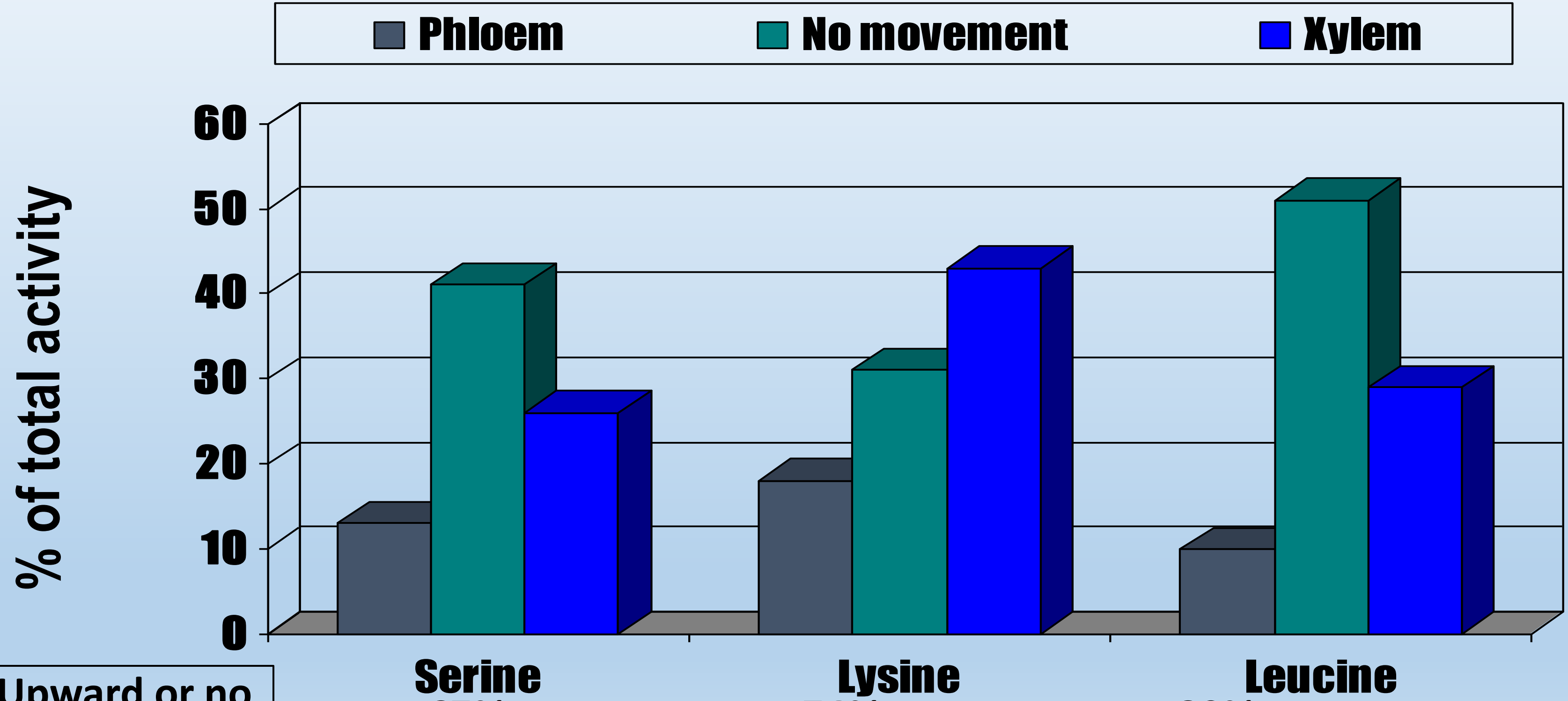
Stiegler, Crop Science 2013

Translocation of specific AA's in wheat leaves



Petersen et al., 1976

Translocation of AA's in wheat leaves



Upward or no movement → 67% 74% 80%

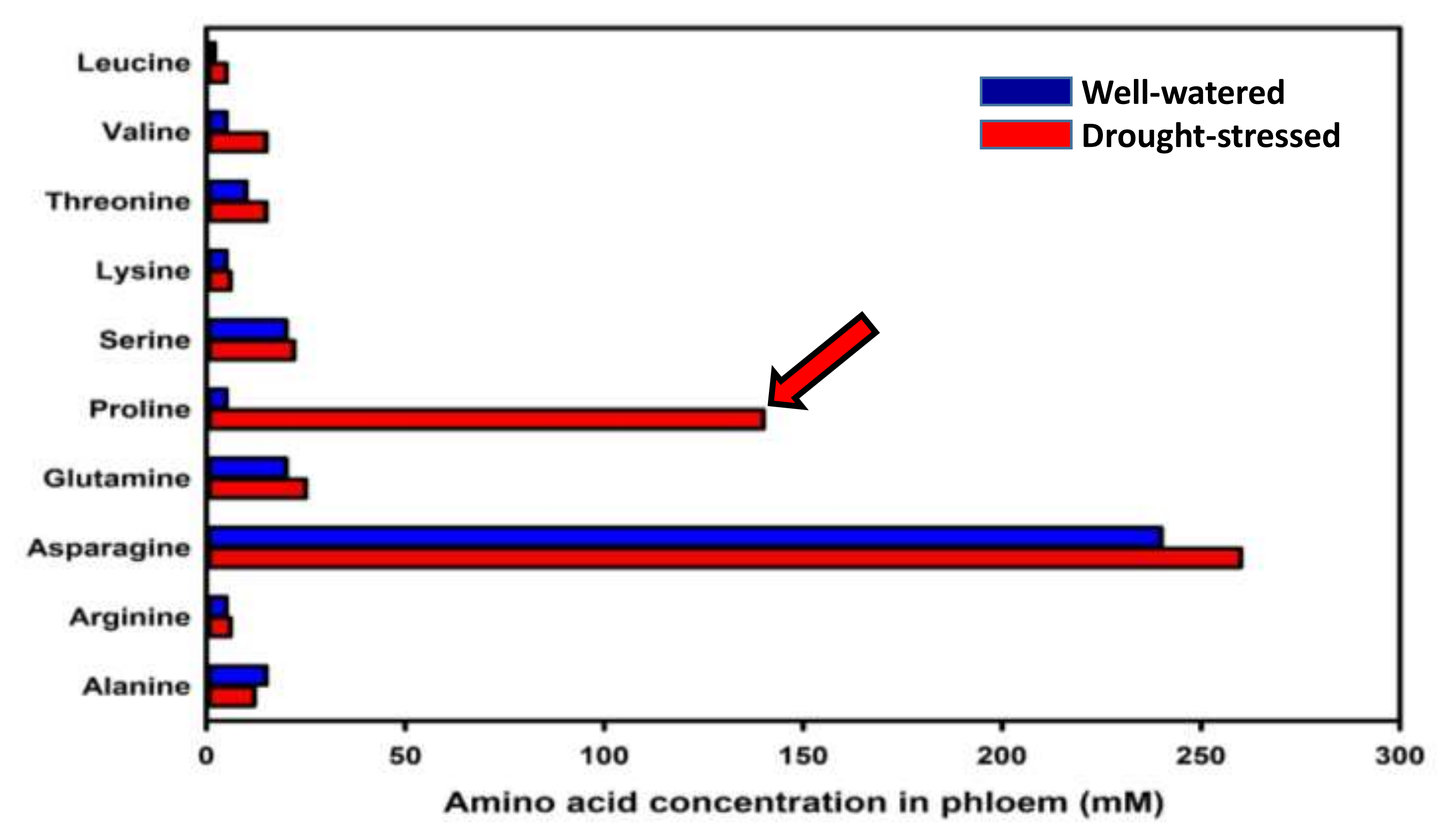
Petersen et al., 1976

Response of creeping bentgrass to a tryptophan-containing biosolid – tryptophan is a precursor in auxin biosynthesis

Treatment	Rooting Biomass	% change vs urea
Tryptophan biosolid	**0.997 a**	**+18.2**
Tryptophan biosolid + Urea	**0.974 a**	**+16.3**
Urea	**0.815 b**	**-**

Mertz, Christians, Ervin, and Zhang, 2014

Effects of drought stress on proline movement in barley



Winter et al., 1991

Do foliar applications of amino acids affect plant health?

Pros

- Uptake appears to be similar to urea
- Specific AA's may promote drought stress or increased rooting

Cons

- Expensive source of N
- Most AA's do not move readily in phloem stream
- Little evidence in turfgrass systems of pros or cons

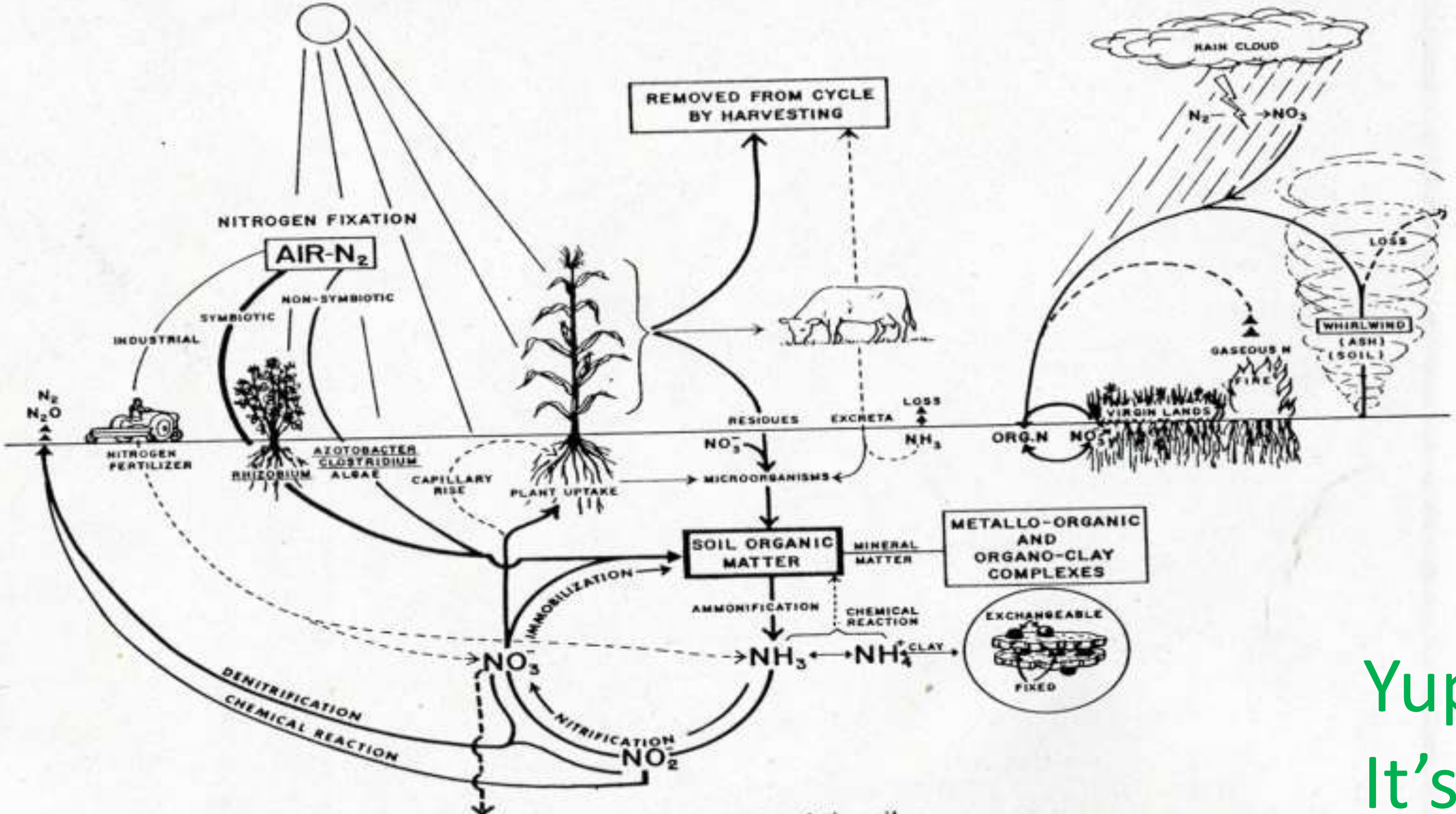


Fig. 1—The N cycle in soil.

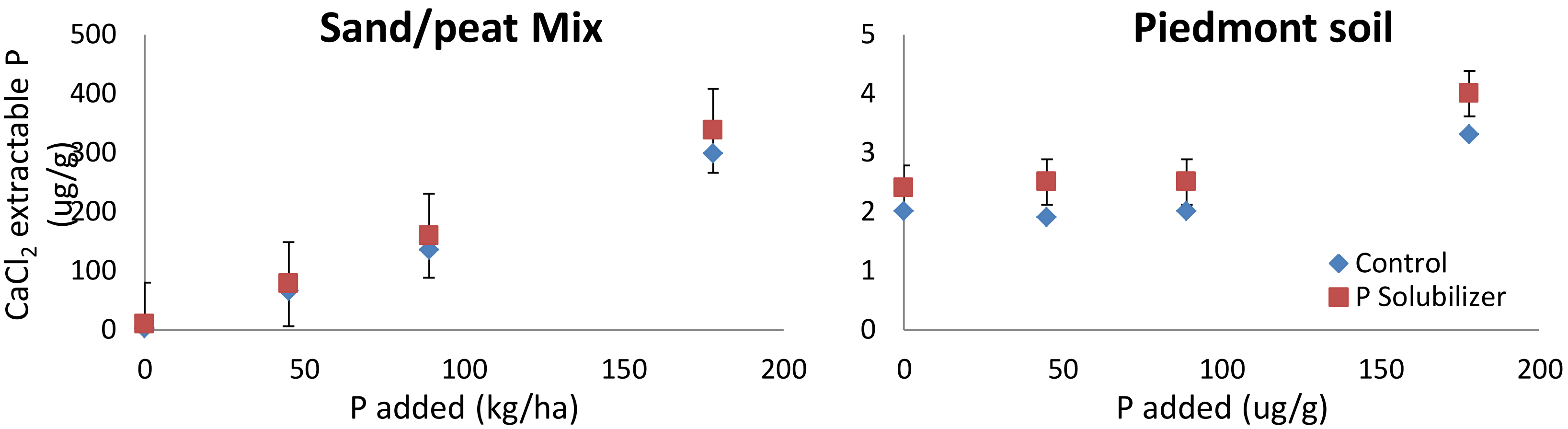
Yup,
It’s true.

Arcaea. Azos Nitrogen Fixing Microbes is the world’s most powerful nitrogen fixing bacteria. First discovered in the Amazon Rainforest and has since been cultured into a high potency inoculant which provides tremendous benefits to plants. Azos boosts root structure and prevents transplant shock and eliminates the need for chemical fertilizers.

Xtreme Gardening's Azos allows plants to ingest up to 90% of their nitrogen needs straight from the atmosphere and utilizes the air we breath in order to sustain crops, naturally.

Effects of various fertilizer treatments on clipping yield and root dry weight of tall fescue, greenhouse study, Auburn, AL. Products applied at an N rate of 2 lbs of N per 1,000 square feet.

	Dry weight of harvested clippings				
Treatment	Week 3	Week 6	Week 9	Week 12	Roots – week 12
	dry weight in grams per pot				
Control soil	0.095 b	0.078 b	0.17 b	1.4 b	1.5 b
10-10-10 synthetic with archaea	0.291 a	0.42 a	0.31 a	2.4 a	3.4 a
10-10-10 synthetic only	0.252 a	0.45 a	0.38 a	2.1 a	2.2 ab



Effect of inclusion of a P solubilizing bacteria on extractable soil P.

Thatch depth as affected by various factors, bentgrass putting green.

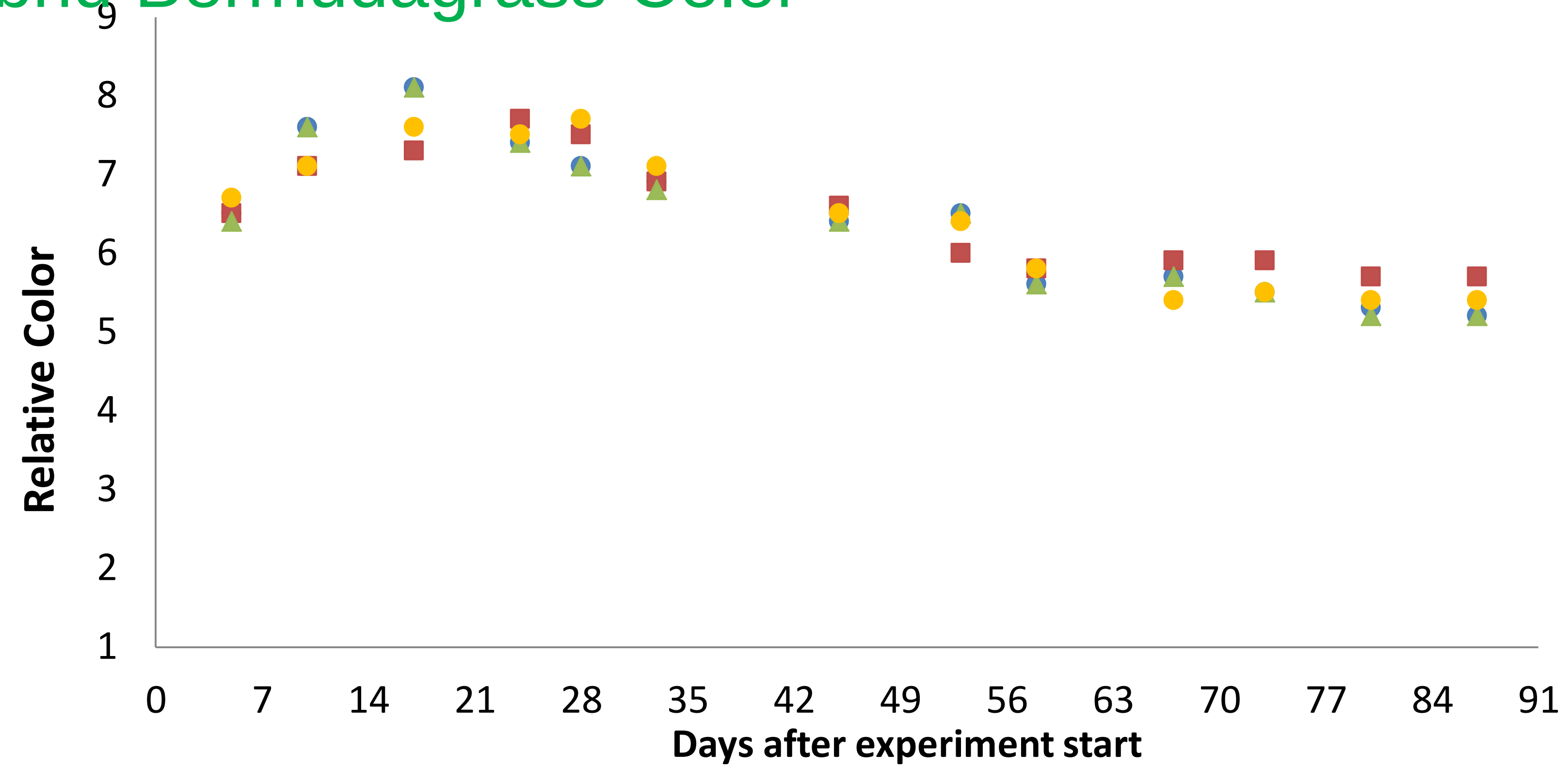
Product is a mix of *Bacillus subtilis* and *B. licheniformis* strains.

Factor	Thatch depth (mm)					
	Date					
Grass	April 26	May 30	June 16	Sept 3	Oct 22	Nov 6
Crenshaw	11.3 a	10.5 a	10.8 a	11.0 a	18.6 a	17.0 a
Penncross	11.1 a	10.4 a	8.4 b	10.3 a	16.4 b	15.1 b
VM						
YES	11.1 a	10.2 a	9.1 b	9.9 b	17.0 b	16.0 a
NO	11.2 a	10.7 a	10.2 a	11.3 a	18.0 a	16.1 a
Topdress						
YES	11.2 a	11.0 a	10.3 a	10.2 a	19.1 a	17.6 a
NO	11.2 a	9.9 b	9.0 b	11.0 a	15.9 b	14.4 b
Bio-thatch						
YES	11.2 a	10.2 a	9.7 a	10.6 a	17.1 b	15.6 b
NO	11.2 a	10.7 a	9.6 a	10.7 a	17.8 a	16.4 a

Summary of the 2 year study

Factor	
Grass	
Crenshaw	⇨ Often higher in this more aggressively growing bentgrass.
Penncross	
VM	
YES	⇨ Often significantly decreased thatch.
NO	
Topdress	
YES	⇨ Often significantly increased thatch – sand accumulation.
NO	
Bio-thatch	
YES	⇨ Significantly decreased thatch in 4 of 22 measurement dates.
NO	

Another Fertilizer BioEnhancement Product - Hybrid Bermudagrass Color



Clipping yield, shoot density and dry weight of roots of hybrid bermudagrass as affected by BioEnhanced Fertilizer. Shoot density was collected from two 2.5 inch diameter soil cores. Experiment initiated on July 30 2011. 24-0-5 N Source

Biological	Data collected								
gal/ton	Clipping yield (grams per plot)				Shoot density (shoots per core)			Root wt (g)	
0	2.8 c	3.2 c	1.3 c	1.1 c	155 b	171 b	171 a	14.8 a	3.9 a
1.0	5.1 b	7.0 b	3.6 b	3.4 b	162 b	189 a	175 a	13.1 a	3.1 b
1.5	8.3 a	11.3 a	4.8 a	4.9 a	184 a	192 a	177 a	13.2 a	2.7 b

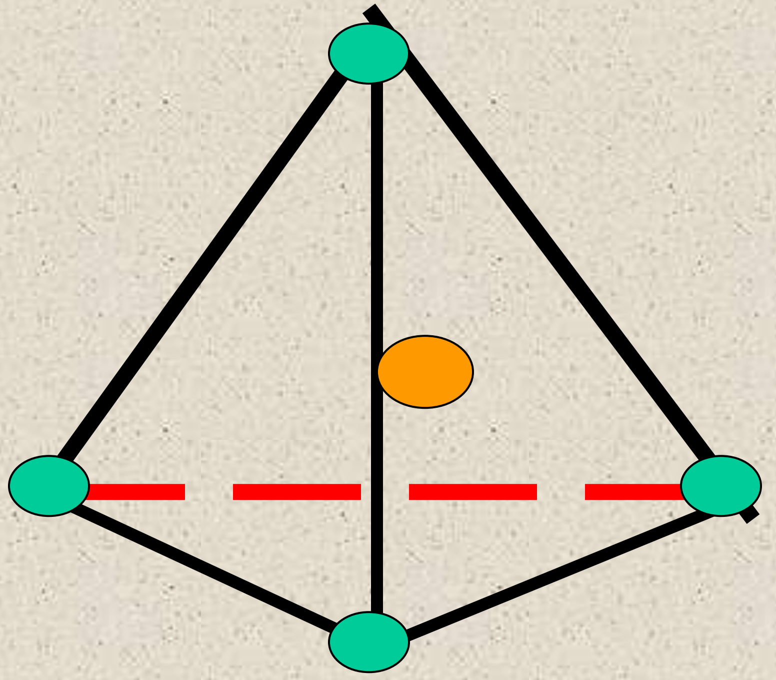
For each date, means followed by the same letter are not significantly different from each other via means separation at an alpha of 0.10.

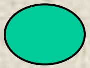
Constituents of Minerals

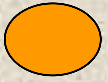
Two Basic Building Blocks

- Si tetrahedron & Al Octahedron

Si tetrahedron



 = Oxygen

 = Silicon

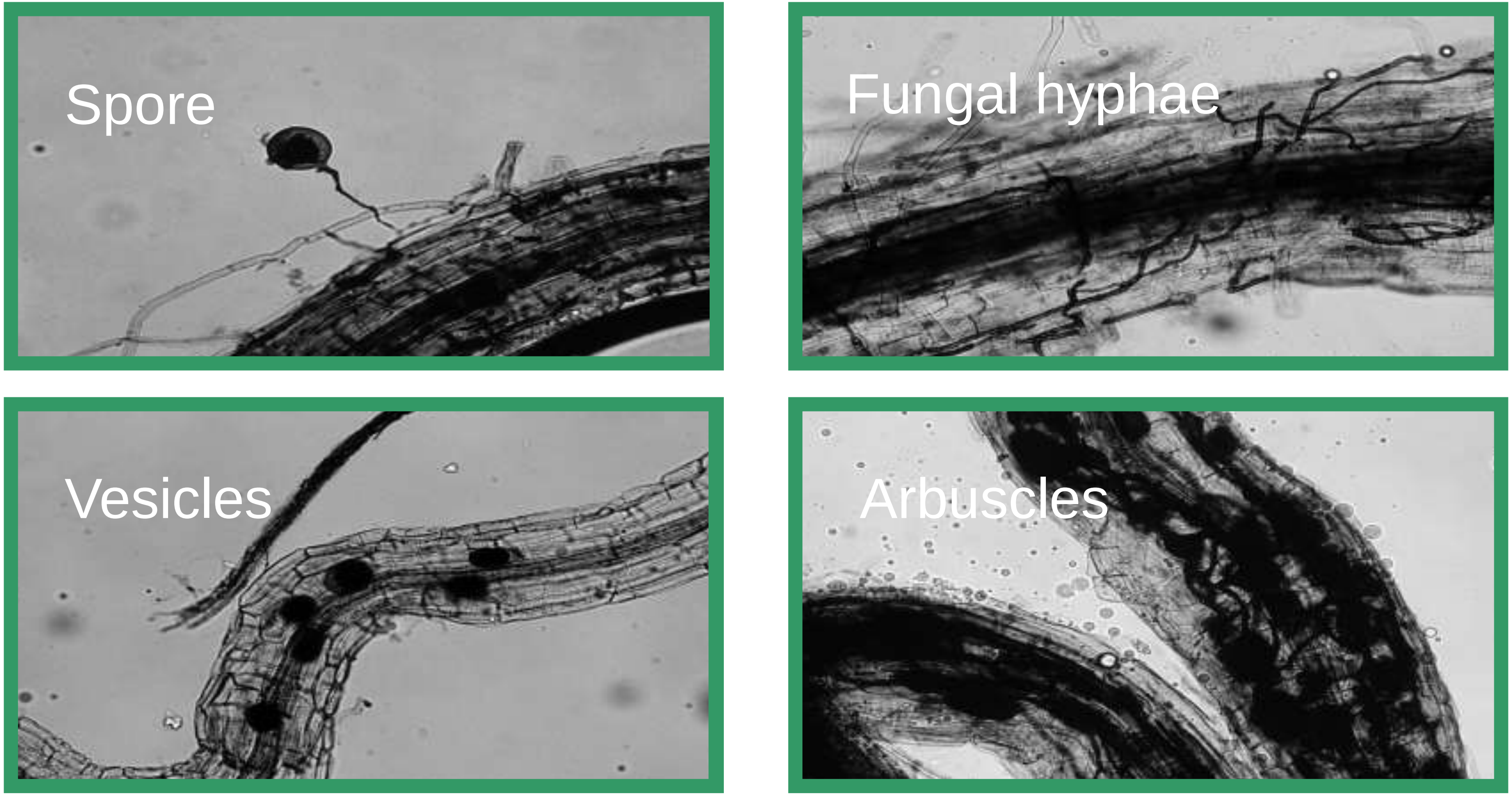
98% of Earths crust (weight basis)

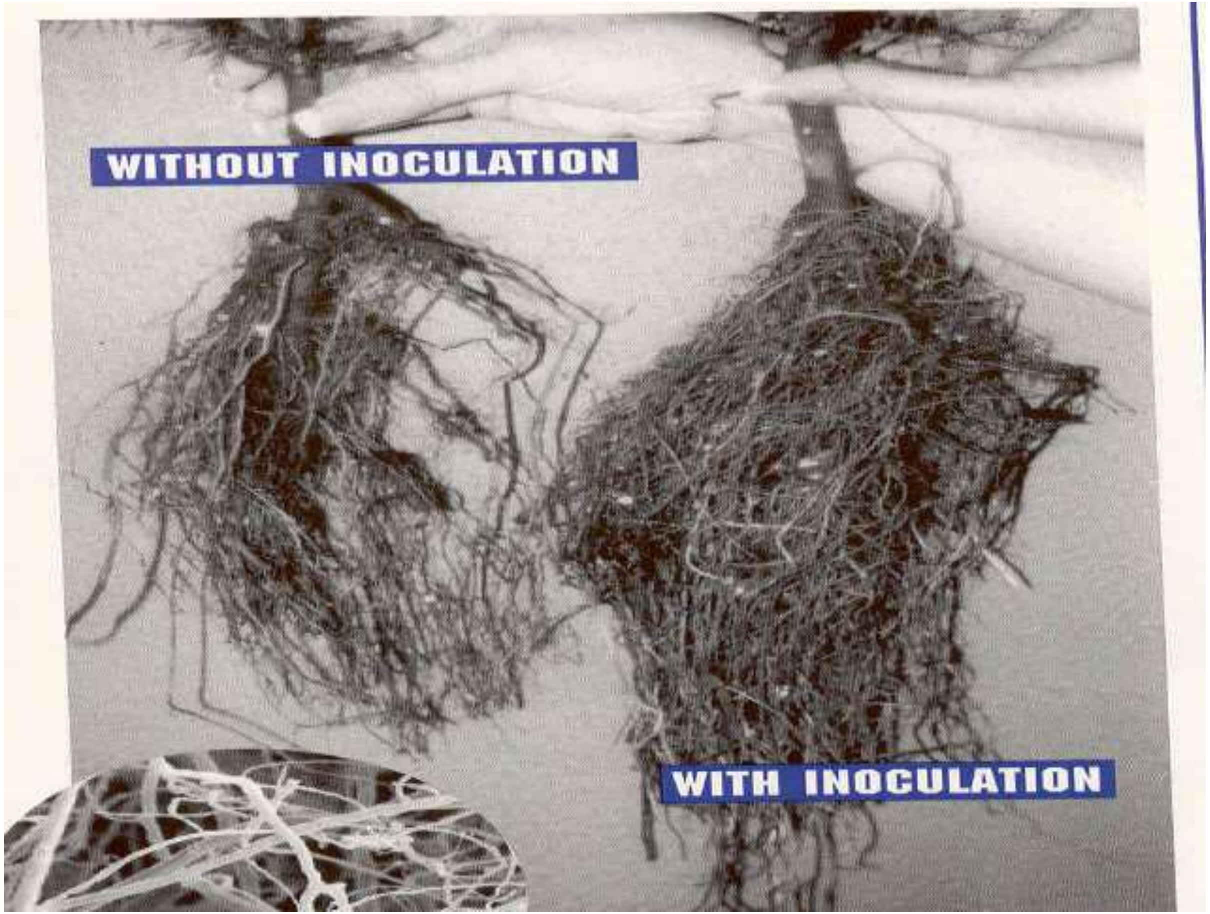
• Oxygen	O	46.6%
• Silicon	Si	27.7%
• Aluminum	Al	8.1%
• Iron	Fe	5.0%
• Calcium	Ca	3.6%
• Sodium	Na	2.8%
• Potassium	K	2.6%

VAM

Vesicular-Arbuscular Mycorrhiza

- Endophytic microorganism. Fungi.
- Infect 90% of all vascular plants, including most agricultural crops. Extensively documented.
- Form vesicles (storage or reproductive structures) and arbuscules (branched hyphal structures).
- Mycelia (immense network of fine threads called hyphae) explore a large soil volume.


Spore
Fungal hyphae
Vesicles
Arbuscles


WITHOUT INOCULATION
WITH INOCULATION

Yes, they are there.

- 200 samples of creeping and velvet bentgrass from golf greens across New England.
- Every sample contained VAM fungi.
- 29 species in all.

Koske et al., 1995

Glomus intraradices – most common commercial source.

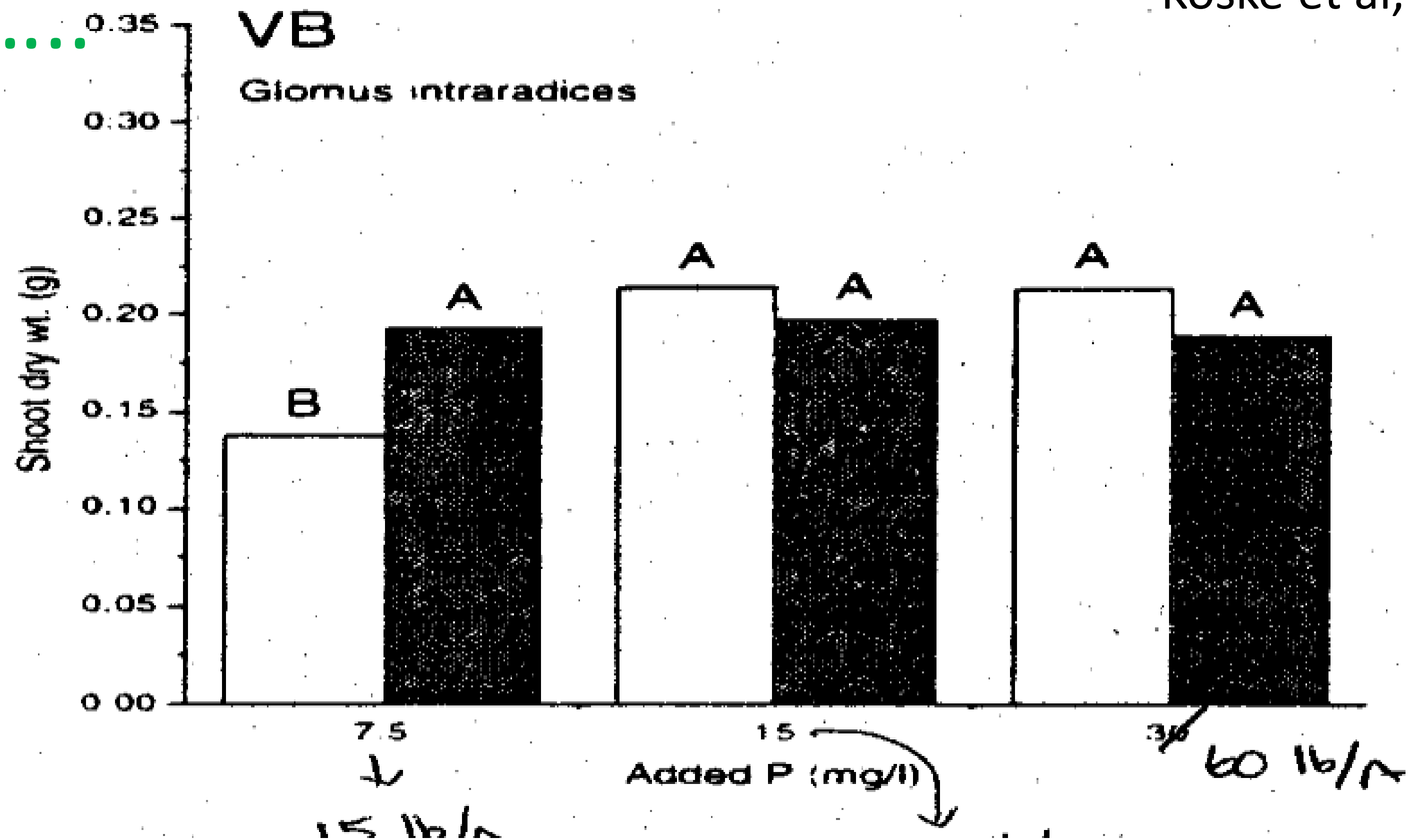
It works:

- Better drought stress.
- 60% less drought stress after 8 days with no water)
- Better regrowth after drought – better recovery from wilt.
- Greener, better growth.
- Higher chlorophyll content.

Koske et al., 1995

BUT.....

Koske et al, 1997



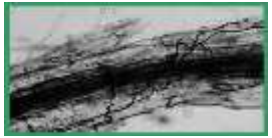
BUT:

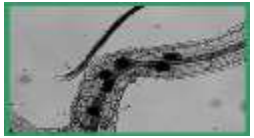
- Very specific P range in which VAM enhance growth.
- Naturally infect by growth from edge of green.
- Specific species infection.
- Various pesticides may affect infection.
- They do infect, they work in low-input systems.

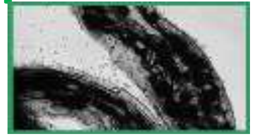
(Koske et al., 1997)

VAM infect naturally.

Crenshaw. Dec, Feb, April samples.







	Hypha	Vesicle	Arbuscule
		percent infection	
No SubAir	53.1 a	2.22 b	7.04 a
SubAir running	57.6 a	4.17 a	7.92 a
NO TE	52.5 b	3.10 b	6.07 a
Trinexapac-ethyl	62.6 a	5.23 a	9.77 a

Auburn, AL 2 year study.

Feng et al., 2002

and stress. There are eight species of EndoMycorrhiza in this product :

- Glomus mosseae
- Glomus intraradices
- Glomus clarum
- Glomus monosporus
- Glomus deserticola
- Glomus brasilianum
- Gigaspora margarita
- Glomus aggregatum

Guaranteed analysis

Total Nitrogen (N)	3.0%
0.5% Water Soluble Nitrogen (N)	
2.5% Water Insoluble Nitrogen (N)	
Available Phosphate (P_2O_5)	3.0%
Soluble Potash (K_2O)	4.0%
Calcium (Ca)	9.0%
Magnesium (Mg)	0.8%
0.8% Water Soluble Magnesium (Mg)	
Sulfur (S)	1.5%
1.5% Combined Sulfur (S)	
Iron (Fe)	1.0%

Derived from: Composted Poultry Manure, Ferrous Sulfate, and Potassium Sulfate.

Non-plant food ingredients: Kelp Meal, Humus, Vitamins, Amino-acids, and EndoMycorrhiza spores.


PENNINGTON SEED
SMART SEED
MYCO Advantage
For A Healthier, Thicker Lawn That:
SUN & SHADE
SMART SEED
SMART SEED
SMART SEED
SMART SEED