This talk details how certain biostimulants may help improve C3 summer stress tolerance

Erik H. Ervin, Ph.D.: Virginia Tech

Summer Stress alters Physiology

W[illegible]anc

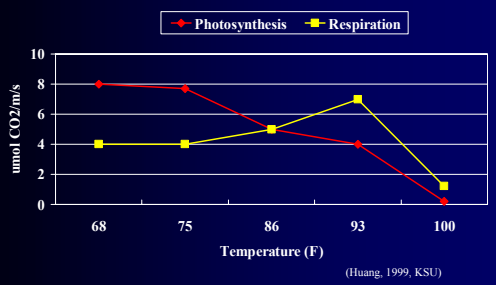
Summer is the season of depletion for C3 grasses

Respiration to maintain root and shoot systems increases dramatically

More carbohydrates are used than stored

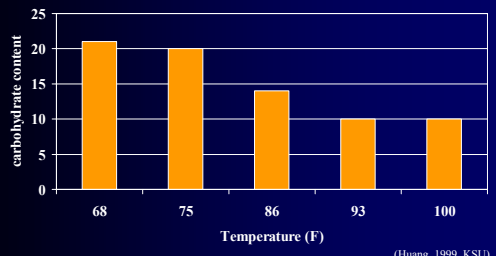
Growth hormones become depleted (CK, IAA) and plant begins to shut down

Increasing air temperatures cause net energy loss of Penncross creeping bentgrass (water not limiting)



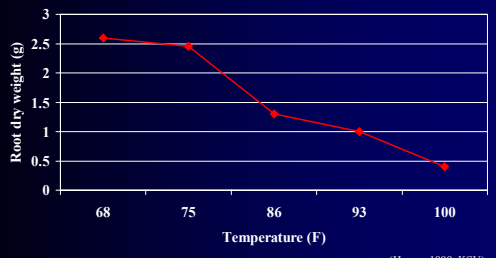
(Huang, 1999, KSU)

Shoot carbohydrate content is reduced by increasing air temperatures in Penncross (water not limiting)



(Huang, 1999, KSU)

Increasing air temperatures reduce root dry weight of Penncross creeping bentgrass (water not limiting)

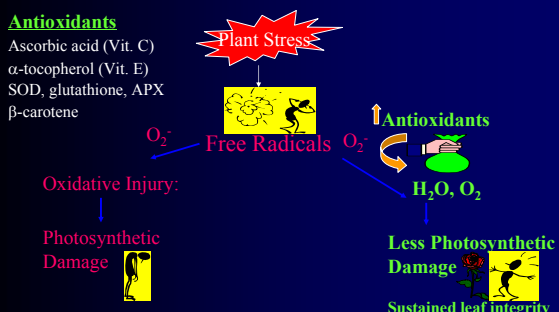


(Huang, 1999, KSU)

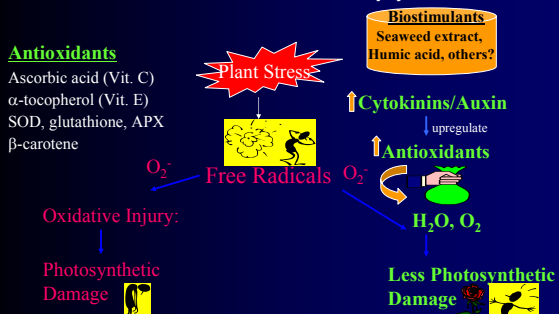
Bentgrass Responses to Summer Stress

- C3 grasses capture about 70% sunlight with chlorophyll for photosynthesis; the rest must be reflected (green) or absorbed by other pigments (carotenoids, anthocyanins) or anti-oxidants
- If not used/quenched this excess energy causes oxygen radicals to be formed that react to destroy chlorophyll, membranes, DNA, proteins
- **RESULT: Blades being worn on the outside and bombarded on the inside pull more energy from the roots**

Plant stress causes the formation of free radicals (O_2^-) resulting in photosynthetic damage.



Plant stress causes the formation of free radicals (O_2^-) resulting in photosynthetic damage. Plants pre-conditioned to develop high concentrations of antioxidants resist oxidative injury



Biostimulants are:

Not fertilizers

Not pesticides with % active ingredients and EPA-regulated efficacy and safety data

Not substitutes for standard cultural practices

Tools for supplementing standard practices

Organic compounds of plant or animal origin that may improve plant metabolic responses to stress

Biostimulants: A mixed bag

Products available: 3D, IronRoots, PanaSea, Focus, Macrosorb, AquaRoot, Plasma, etc.

IronRoots

P:	2.0%
K:	4.0%
Fe:	4.0%
HA:	2.6%
SWE:	2.0%
Vit. C:	2.7%
Vit. E:	0.1%

Focus

P:	0.0%
K:	6.0%
Fe:	1.4%
HA+FA:	35.4%
SWE:	4.8%

3D

SWE
HA
Fe
micros

Biostimulants: A mixed bag

Plasma

N: 12%
P: 4%
K: 8%
Fe: 0.1%
Mn: 0.05%
Zn: 0.05%
SWE + HA

Macrosorb-f

N:	2.0%
B:	0.02%
Mn:	0.05%
Zn:	0.07%

Amino acids: 21.3%
Organic matter: 14.8%

AquaRoot

HA
wetting agent

CPR

SWE: 33%
Fe: 2% chelated
Micros package
Wetting agent

Biostimulants: A mixed bag

Some products contain "beneficial" microbes

Turf Vigor

Bacillus sp. (300 billion/gal)
Paenibacillus sp. (83 billion/gal)
SWE
9% N, 3% P, 6% K, Fe, Mn, Zn

Seaweed Extract (SWE) is one of the main active ingredients in biostimulants

SWE's are alkaline extracts from the brown algae (kelp) *Ascophyllum nodosum* from N. Atlantic Ocean

What's in SWE?

Cytokinin (0.007% = 70 ppm)*; auxin (0.0006%); carbohydrates (62%); amino acids; N (1%); P (0.05%); K (10%); Ca (1.2%); Mg (0.8%); S (3.7%); Fe (0.001%); Cu, Mn, Zn, B

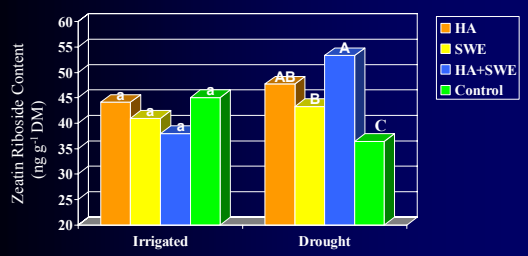
*Ervin and Zhang, 2002; rest from Senn, 1987: Seaweed and Plant Growth

Seaweed (*Aschophyllum*)

Other uses:

- Asian foods
- Animal feed
- Ice cream, alginate
- Paints, cosmetics, fibers

'Penncross' zeatin riboside content as affected by HA and SWE under two soil moisture levels (2002)



Our SWE source/rate contains 70 ppm ZR; this graph shows only need 40 ppb for proper physiological activity
A 1000-fold difference

SWE: 5 g/M = 0.5 lb/A = 8 oz/A

At this rate about 0.0004 lb N/M is applied

Humic Acid (HA) is present in any type of organic matter

Our HA source is extracted at pH 2.0 from leonardite (a form of lignite coal).

What's in HA?

Carbon:	54-59%	Reed-sedge peat contains 21% HA
Hydrogen:	3-6%	Sphagnum peat contains 8% HA
Oxygen:	33-38%	Leonardite contains 50-93% HA
Nitrogen:	1-4%	
Sulfur:	0-2%	and Amino acids, auxin, and polyamines

Humic Acid

At 0.05 to 0.10% concentrations HA has been shown to mimic IAA (auxin) in promoting root growth.*

HA also chelates Fe in an exchangeable form for root uptake

Our rate is 15 g/M = 0.6 oz/M = 23 oz/A = 0.5% concentration applied in our trials

= 0.001 lb N/M applied

*O'Donnell, 1973. Soil Sci. 16(2):106-112

Humic Acid has been shown to increase PS and root growth

- In a greenhouse experiment, Crenshaw bent was grown in solution culture supplied with non-limiting nutrients (no stress) and 3 concentrations of HA.
- Photosynthesis and root growth was increased significantly from 1 to 4 weeks after treatment by HA at 400 ppm (0.0004%)

VT rate ~5000 ppm

Liu, Cooper, Bowman. 1998. HortScience 33:1023-1025

Monthly treatment of bent with SWE+HA or SWE+HA+Banner increased tolerance to salt water irrigation

Pots watered with 2000 ppm salt solution for 5 weeks

Schmidt&Zhang

HA+SWE increased rooting and sustained G-2 quality during simulated drought

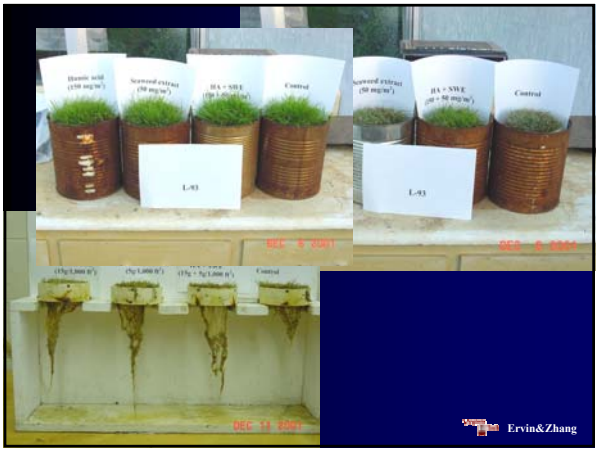
Irrigation withheld for 4 weeks: began 34%, finished 5%

Ervin&Zhang

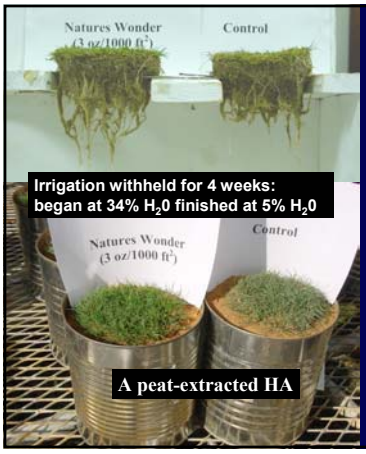
HA+SWE had no effect under optimum temperature and moisture conditions

Ervin&Zhang

Turf kept at FC = 34% H_20



Ervin&Zhang



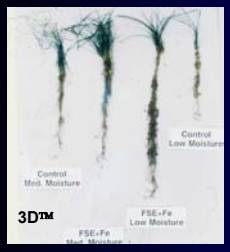
Irrigation withheld for 4 weeks: began at 34% H_20 finished at 5% H_20

A peat-extracted HA

Results from commercial products have also indicated positive effects

Ervin&Zhang

More commercial product research results



3D™

Roots™

Schmidt, Virginia Tech

Mixing Compatibility

Read label closely and consult with product rep

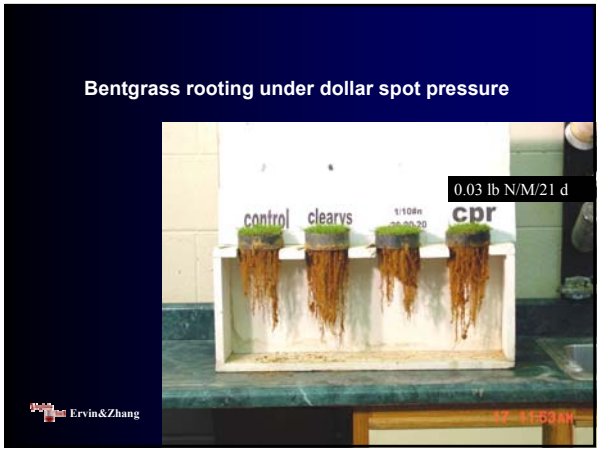
Most mix fine with fungicides and herbicides and may even offer synergism

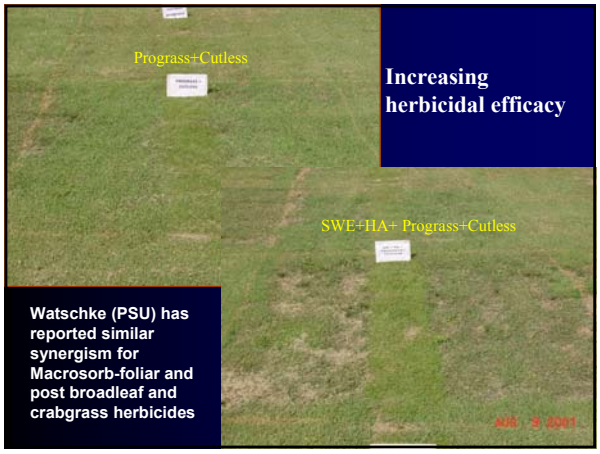
If using an anti-GA PGR such as Primo check with rep to make sure biostimulant does not contain GA.

CPR™ every 21-d decreased dollar spot incidence on Penncross

Ervin&Zhang


Macrosorb foliar™ every 21-d provided minor decrease in dollar spot on Penncross
Ervin&Zhang

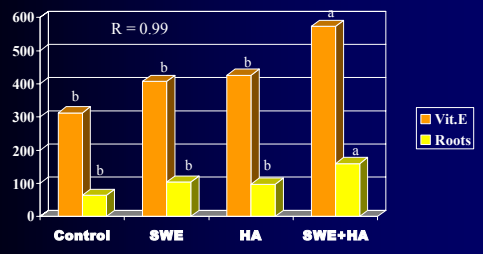

Bentgrass rooting under dollar spot pressure
0.03 lb N/M/21 d
control
clearys
cpr
Ervin&Zhang


Prograss+Cutless
Increasing herbicidal efficacy
SWE+HA+ Prograss+Cutless
Watschke (PSU) has reported similar synergism for Macrosorb-foliar and post broadleaf and crabgrass herbicides

Anti-senescence activity; chlorophyll integrity maintained after 9 d in dark

Schmidt and Zhang, Virginia Tech

Vitamin E concentration and Root mass of drought-stressed KBG as influenced by SWE and HA

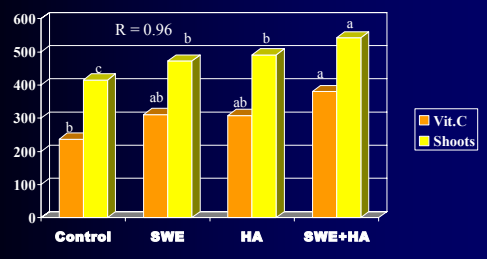


Zhang and Schmidt. 1999. Crop Sci. 39:545-551

Leaf Moisture % and Root mass of drought-stressed Penncross as influenced by SWE and HA

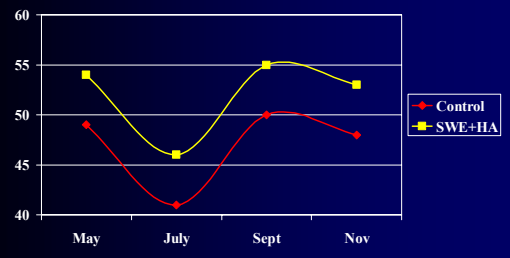
Zhang and Schmidt. 2000. Crop Sci. 40:1344-1349

Vitamin C concentration and Shoot mass of drought-stressed Penncross as influenced by SWE and HA



Zhang and Schmidt. 2000. Crop Sci. 40:1344-1349

Photochemical Efficiency of Bentgrass Fairway as influenced by monthly SWE+HA apps



Schmidt and Zhang, Virginia Tech, 1997

Fe as a biostimulant additive increases color but not rooting or physiological activity

KBG under Salt stress: Nabati & Schmidt. 1994. Crop Sci.34:198

- Increased color: Fe = 7; SWE = 6; Fe+SWE =7
- No rooting effect: Fe = 10; SWE = 21; Fe+SWE = 17

Penncross fairway under mild summer stress: Zhang, Schmidt, Ervin. 2002. HortScience.37:898

- Photosynthetic efficiency: no increase
- SOD activity: no increase
- Fall color: SWE=6.7; SWE+Fe=7.7

Can less N be applied when biostimulants are used?

Makes sense: We have seen that SWE+HA provide a more efficient plant:

- Increased photosynthetic efficiency
- Increased antioxidants
- Increased rooting….get to more soil N

However, more sustained shoot growth during stress will translate into more N use and more N removal with mowing

May balance out: our data has been inconclusive

Product vs. Generic Comparisons

ironRoots2

@ 4 oz/M/month label rate
SWE: 0.08 oz/M
HA: 0.1 oz/M
2% P = 0.005 lb/M
4% K = 0.01 lb/M
4% Fe = 0.2 oz/M
Vitamins C, B_1, E

VT SWE+HA

SWE: 0.2 oz/M
HA: 0.6 oz/M

Standard Fe-sulfate rate:
2 oz/M = 0.4 oz Fe/M

Product vs. Generic Comparisons

Focus

@ 8 oz/M/month label rate
SWE: 0.4 oz/M
HA+FA: 2.8 oz/M
6% K = 0.03 lb/M
4% Fe = 0.1 oz/M

VT SWE+HA

SWE: 0.2 oz/M
HA: 0.6 oz/M

Standard Fe-sulfate rate:
2 oz/M = 0.4 oz Fe/M

Is more always better? Too high of a cytokinin to auxin ratio can inhibit rooting; too much auxin get 2,4-D –like damage

Product vs. Generic Comparisons

CPR
@ 12 oz/M/month label rate
SWE: 4 oz/M

4% N = 0.03 lb/M
1.5% K = 0.01 lb/M
2% Fe = 0.24 oz/M
Mg, Mn, Zn
surfactant

VT SWE+HA

SWE: 0.2 oz/M
HA: 0.6 oz/M

Standard Fe-sulfate rate:
2 oz/M = 0.4 oz Fe/M

Product vs. Generic Comparisons

BioGain
@ 1.5 oz/M/month label rate
SWE: 0.12 oz/M
HA: 0.15 oz/M
3% K = 0.003 lb/M
10% Fe = 0.15 oz/M
Sucrose, Vitamins B,K
Amino acids
Beneficial bacteria

VT SWE+HA

SWE: 0.2 oz/M
HA: 0.6 oz/M

Standard Fe-sulfate rate:
2 oz/M = 0.4 oz Fe/M

Product vs. Generic Comparisons

Flexx
@ 2.5 oz/M/month label rate
SWE: 0.11 oz/M
HA+FA: 0.14 oz/M
3% N = 0.005 lb/M
20% K = 0.03 lb/M
7% Fe = 0.2 oz/M
Mg, S, Mn
Beneficial bacteria
Yucca extract

VT SWE+HA

SWE: 0.2 oz/M
HA: 0.6 oz/M

Standard Fe-sulfate rate:
2 oz/M = 0.4 oz Fe/M

Product vs. Generic Comparisons

Turf Vigor
@ 18 oz/M/month label rate
SWE: 0.1 oz/M

9% N = 0.1 lb/M
3% P = 0.03 lb/M
6% K = 0.07 lb/M
0.6% Fe = 0.11 oz/M
Mn, Zn
Beneficial bacteria

VT SWE+HA

SWE: 0.2 oz/M
HA: 0.6 oz/M

Standard Fe-sulfate rate:
2 oz/M = 0.4 oz Fe/M

Summary

Physiological benefits of Biostimulants containing proper amounts and sources of SWE and HA may best be realized if applied before the onset of environmental stress

- Monthly: Late May through late September
- No stress = little or no effect
- As a supplement not a substitute to a good fertilization program
- Show me the University data for your product!