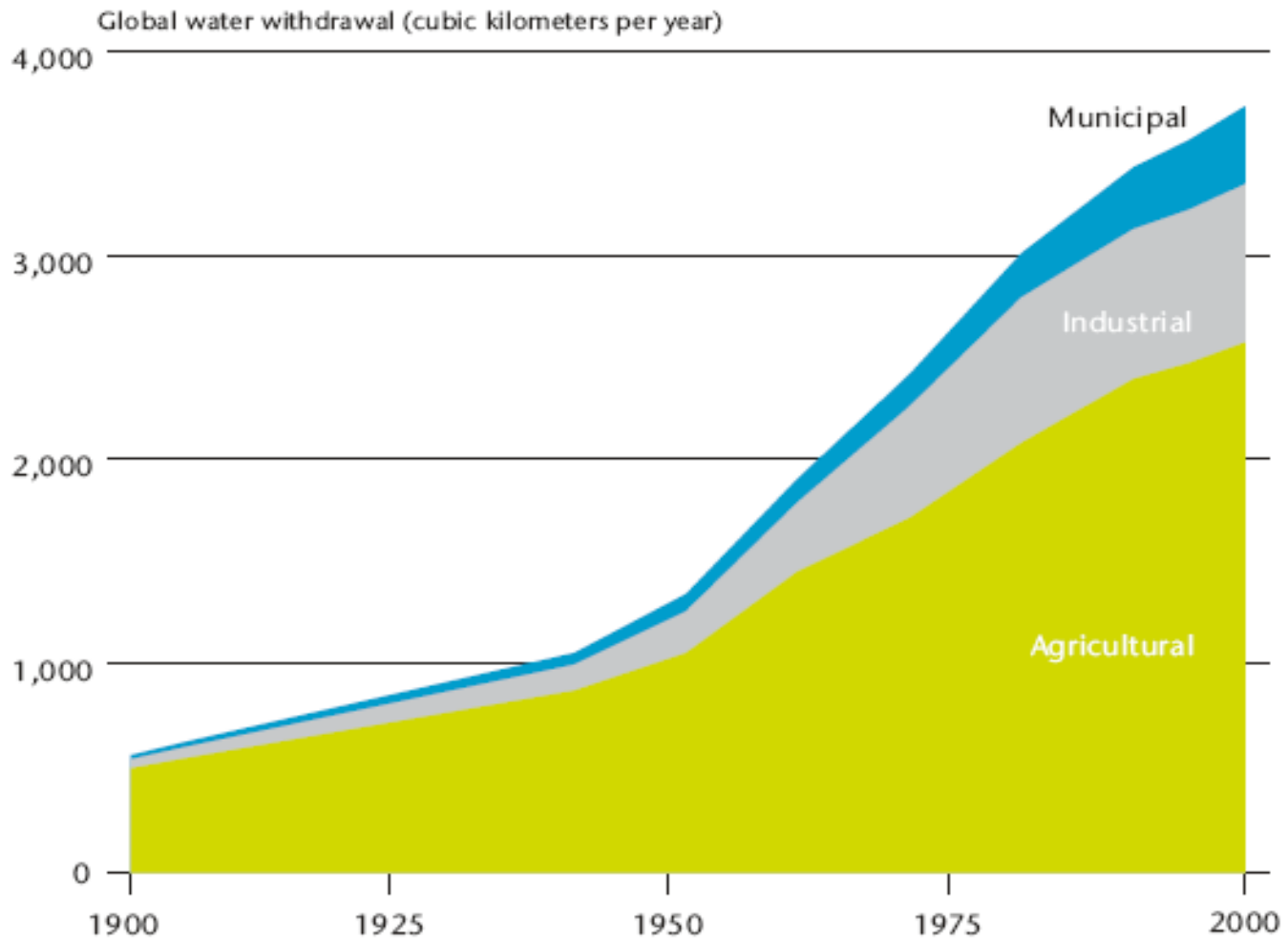


**Strategies to improve crop
water productivity
or
How do we get more crop per
drop?**

**Stan Kostka, PhD
Director of Technology and Business Development
Aquatrols Corporation**

**Minneapolis, MN
May 2011**



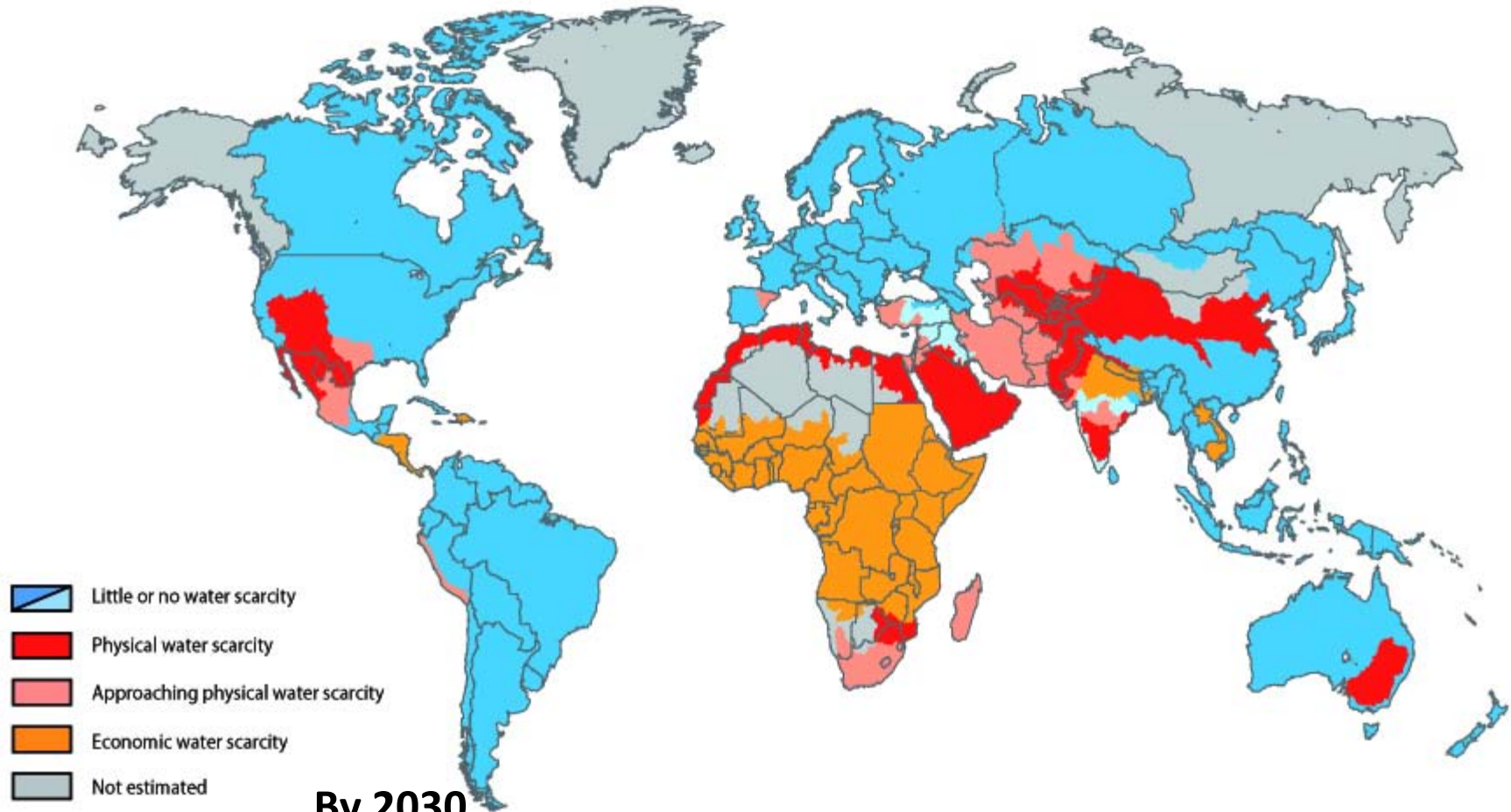
70% of freshwater is used for agriculture



World Business Council for Sustainable Development



Areas of physical and economic water scarcity



Source: IMWI report, Insights from the Comprehensive Assessment of Water Management in Agriculture, 2006 / p8

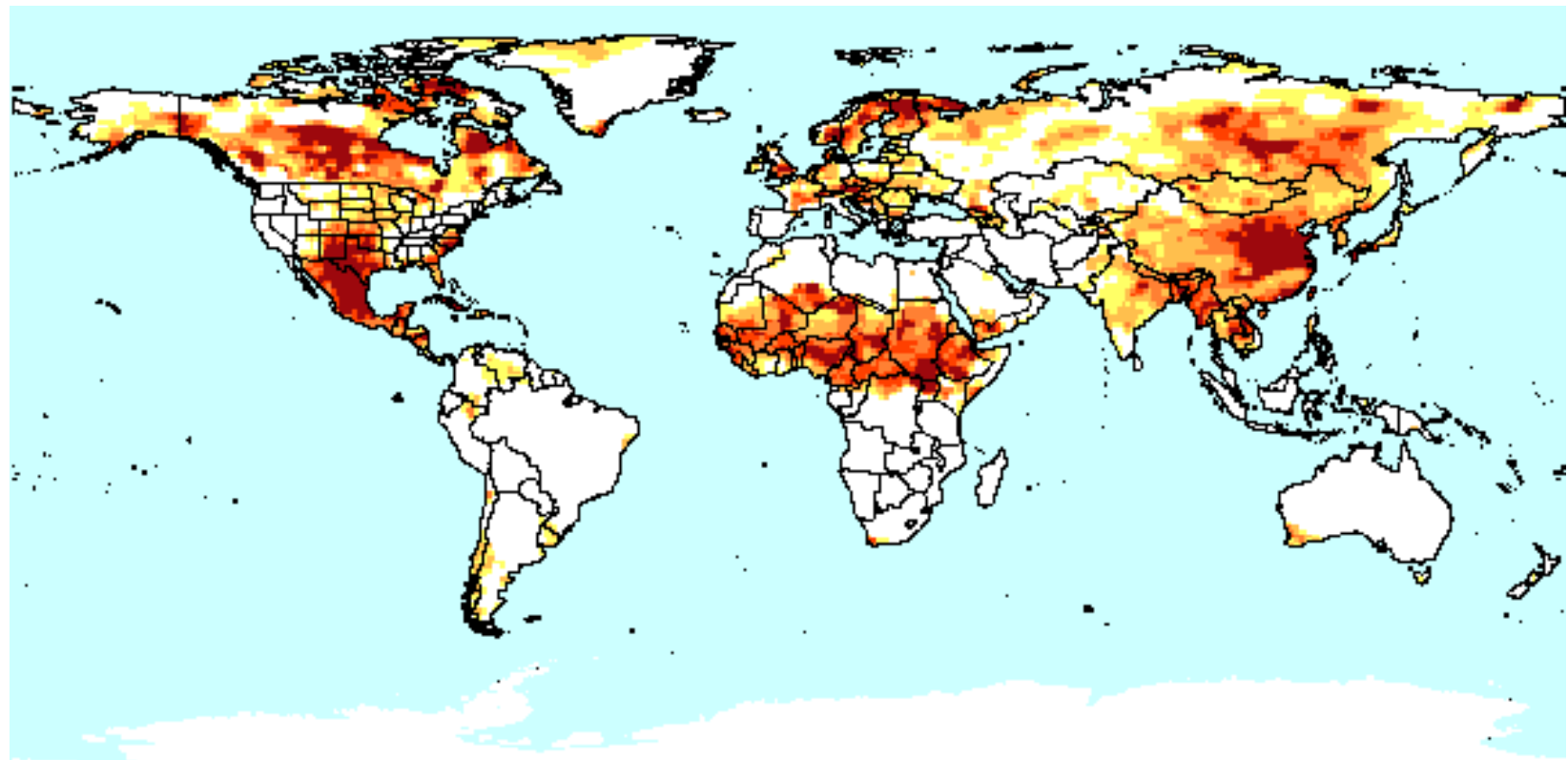
By 2030

Demand anticipated to out strip water supply by 40%
Two thirds of nations ranked as water stressed

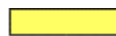
By 2050

World population exceeds 9 billion
Food production must increase by 50%

Global Drought Monitor



Drought Severity



Minor Drought



Moderate Drought



Severe Drought



Extreme Drought



Exceptional Drought

May 16, 2011

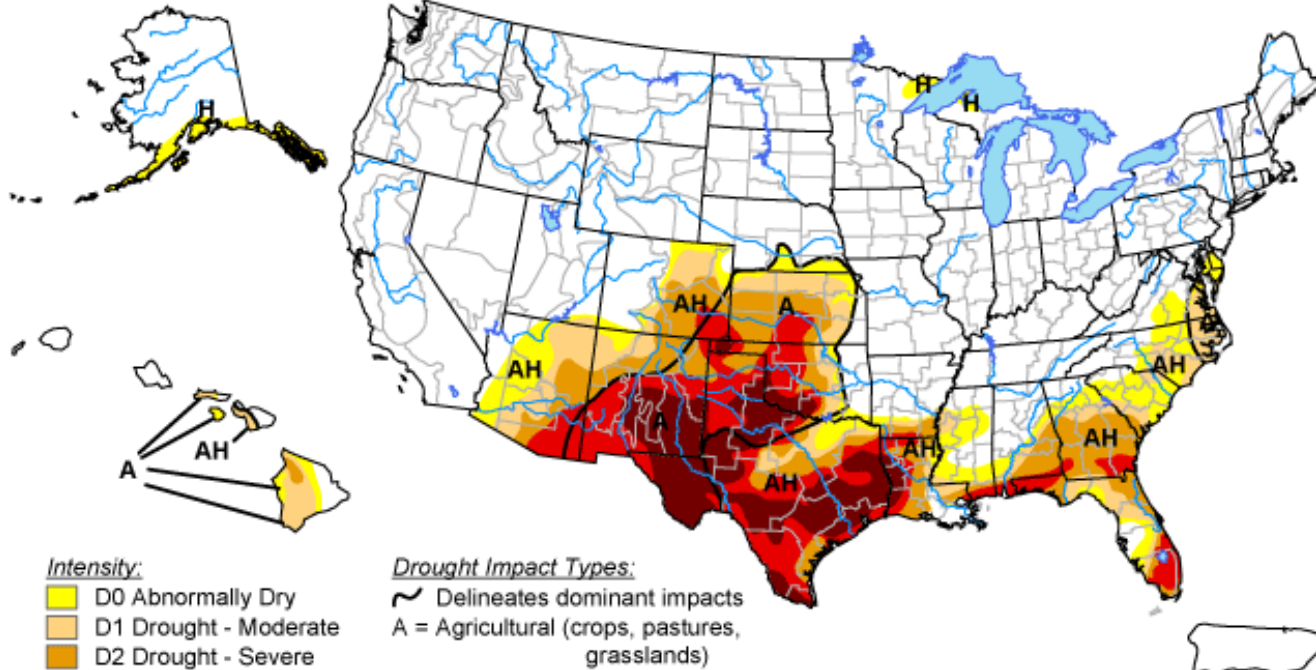
Source: University College – London
Department of Space and Climate Physics








Texas Drought 2011: State Endures Driest 7-Month Span On Record

U.S. Drought Monitor


May 17, 2011
Valid 8 a.m. EDT



Intensity:

-  D0 Abnormally Dry
-  D1 Drought - Moderate
-  D2 Drought - Severe
-  D3 Drought - Extreme
-  D4 Drought - Exceptional

Drought Impact Types:

-  Delineates dominant impacts
- A = Agricultural (crops, pastures, grasslands)
- H = Hydrological (water)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

<http://drought.unl.edu/dm>



Released Thursday, May 19, 2011
Author: David Miskus, NOAA/NWS/NCEP/CPD

Bloomberg

Crop Weather Damage Grows as Europe Drought, Canada Rain Boost Grain Costs

By Whitney McFerron and Elizabeth Campbell - May 10, 2011 5:54 PM ET

The Telegraph

Friday 20 May 2011

Crops: drying a slow death

The lack of rain is destroying crops, bringing chaos to the farming industry and threatening a steep rise in food prices.

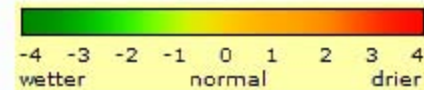
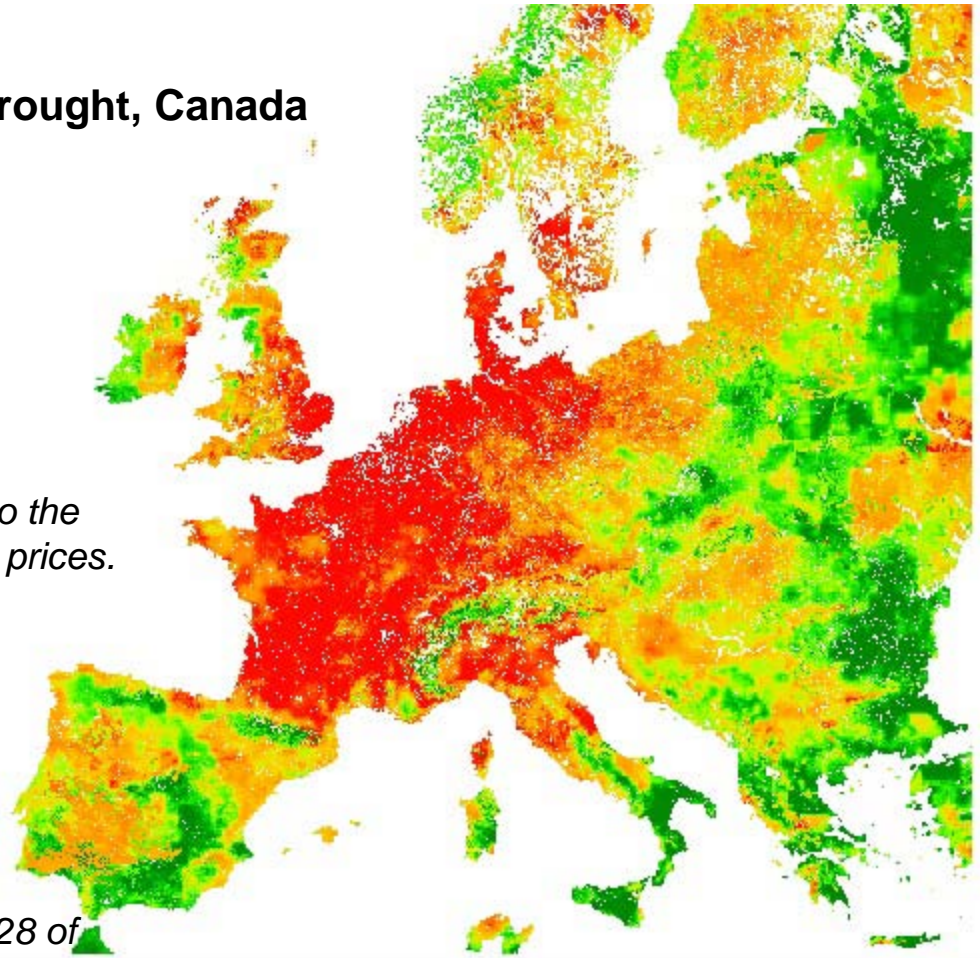


REUTERS

May 16, 2011

France in crisis as drought deepens...

France has imposed limits on water consumption in 28 of its 96 administrative departmentsamid signs that a prolonged dry spell that has hit grain crops would continue.



May 10, 2011

Strategies to improve crop water productivity



Precision Irrigation

GM Crops

Polymers

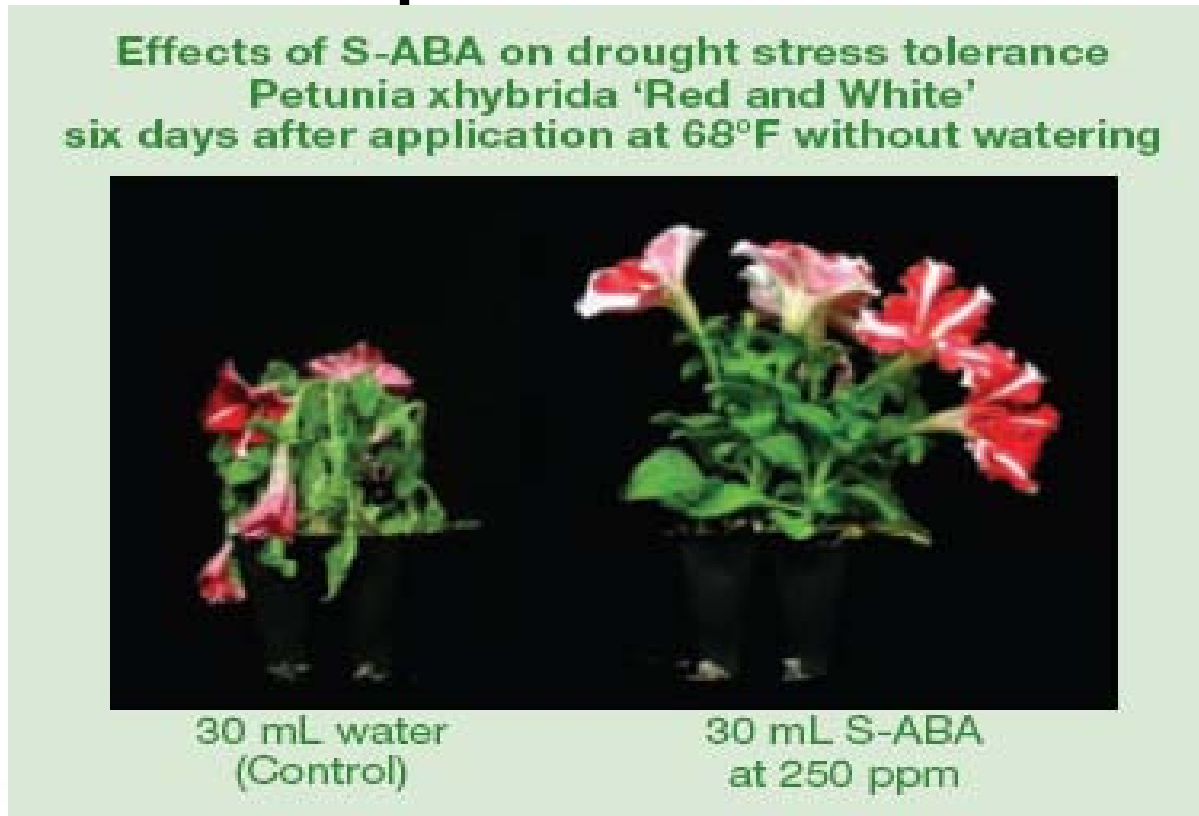
Plant Growth Regulators

Transpiration Modifiers

- Anti-Transpirants
- Particle Film Technology

Soil Surfactants and Adjuvants

How may plant growth regulators affect plant water use?



S-ABA treatment requires a non-ionic surfactant. What are the most effective?

Effects of pyraclostrobin on water use in wheat (*Triticum aestivum* L.)

Wheat Variety	Water uptake (g/g/day)	
	Control	Treated
Variety 1	5.76	4.75*
Variety 2	6.50	5.38*
Variety 3	4.96	3.99*
Variety 4	5.85	4.79*

LSD (P < 0.05)

0.56

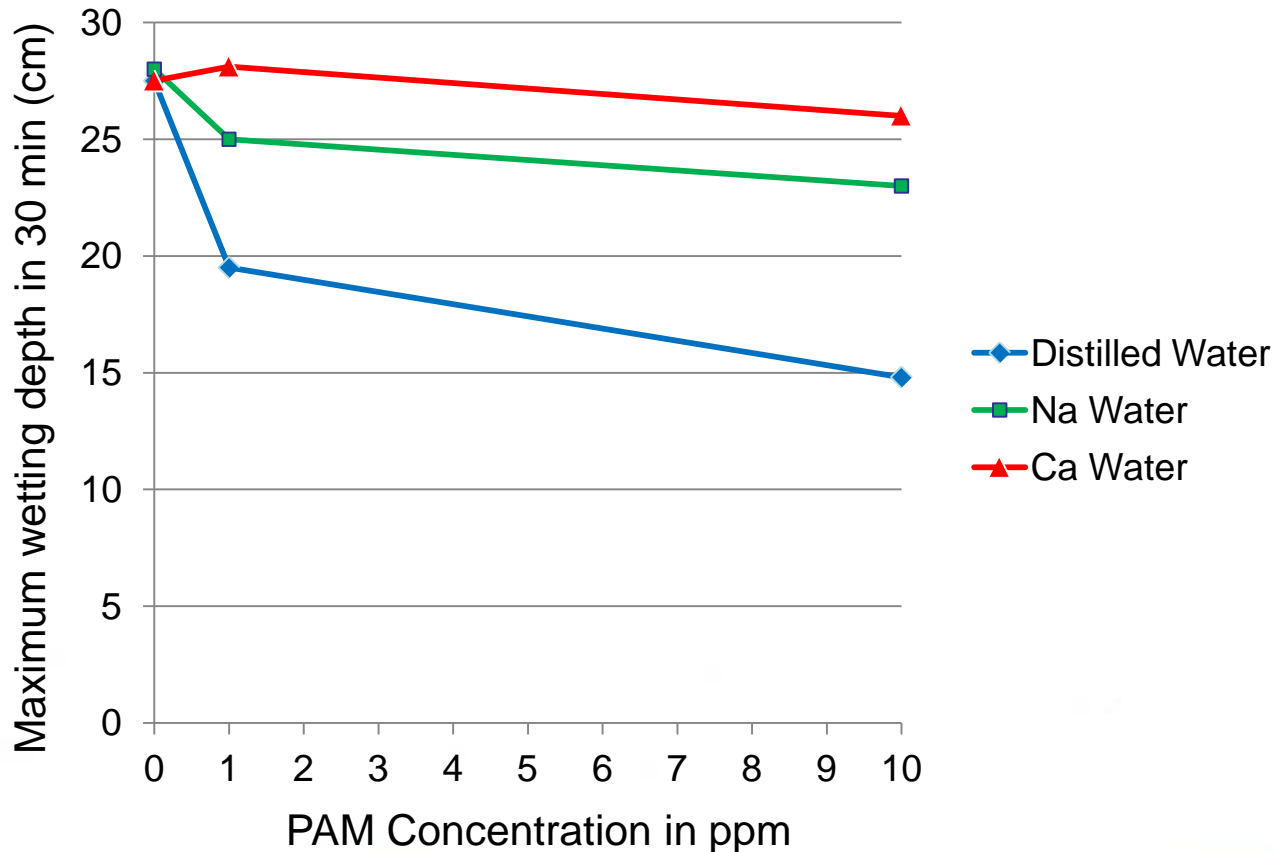
Wheat Variety	Yield (g/m ²)	
	Control	Treated
Variety 1	435	470*
Variety 2	415	420 ^{ns}
Variety 3	412	470*
Variety 4	273	273 ^{ns}

LSD (P < 0.05)

30.3

How may surfactants influence performance?

PAM effects on infiltration depth as influenced by water chemistry

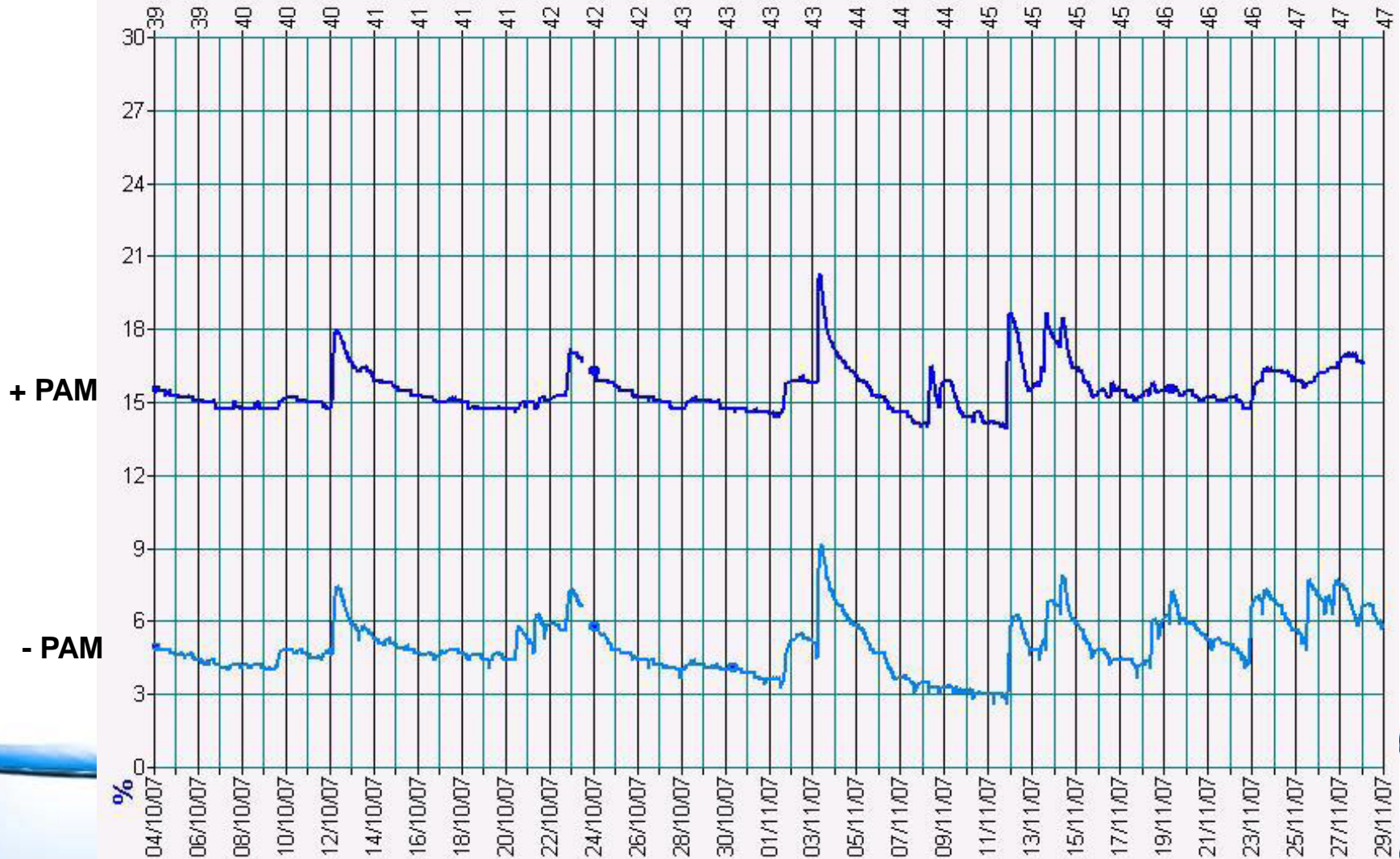


Modified from: Phillips, S. *Effects of polyacrylamides on the physical properties of some light textured soils*, University of Adelaide, 2007, 82p.

What is the effect of PAM on soil moisture?

■ 4265 - Soil Moisture

■ 5116 - Soil Moisture



But what is the effect on yield?

How may an anti-transpirant affect potato yield 'Atlantic' when applied during hot, dry spells at tuber bulking? (mean of 3 yrs data - Nebraska)

Anti-Transpirant gal/ac	Surfactant 0.50%	Yield (cwt/ac)	
		>1.88 in	2.25-3.25 in
0	—	301 b	220 b
20	X77	331 a	243 a
20	COC	332 a	251 a
40	X77	333 a	244 a
40	COC	342 a	253 a
LSD _(0.05)		17	16

Effect of particle film technology applied to apple fruit and foliage on soil volumetric water content Victoria, Australia



	Sample Date			
	12/1/07	1/3/08	1/22/08	3/3/08
Control	14.6 b	20.7 b	20.2 b	11.5 b
PFT (5/2.5 kg/100L)	19.6 a	22.4 a	22.7 a	17 a
LSD (P=0.05)	0.93	1.08	1.76	0.81

Effect of particle film technology on apple yield (*Malus domestica* Borkh. 'Gala') Victoria, Australia



	<u>kg/tree</u>	<u>apples/tree</u>	<u>g/apple</u>
Control	24.6 b	176.6 a	142.5 b
PFT (5/2.5 kg/100L)	28.6 a	162.2 a	176.3 a
LSD (P=0.05)	1.65	17.23	11.83

How may surfactants affect soil water?

Sand-Loam Soil

Drip irrigation at 1.9 Liters hr⁻¹

Surfactant (APG-EO/PO Block Copolymer) 10 L ha⁻¹

Wetting patterns at 45 min, 60 min, 24 hr



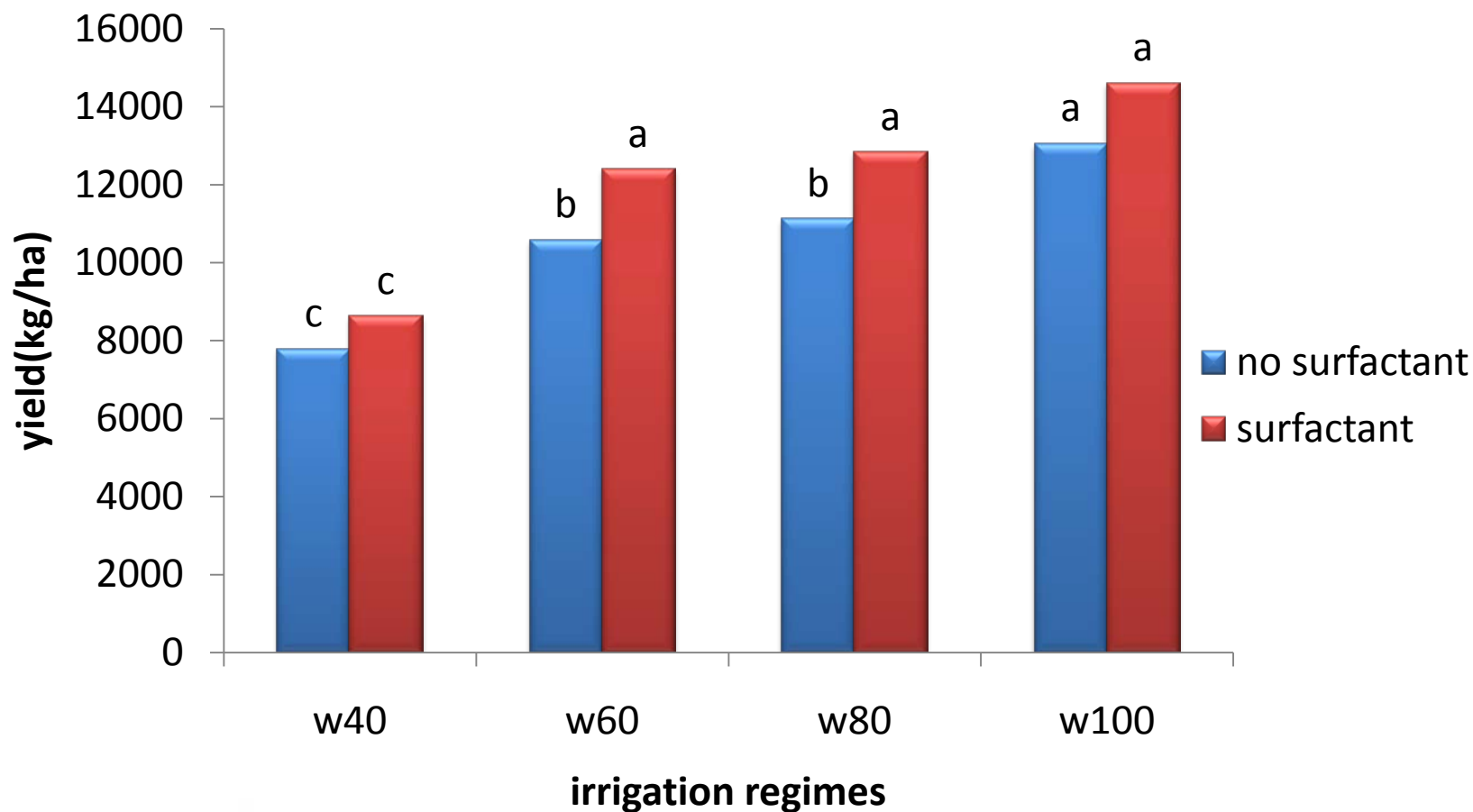
$p = 0.05$

45 min – Surfactant is 20x greater than control
60 min - Surfactant is 2x greater than control
24 hr - Surfactant is 1.4x greater than the control

Can a surfactant influence crop water productivity in drip irrigated maize?



- Randomized factorial strip design, with four replications within each strip.
- Four rates of irrigation (100%, 80%, 60%, and 40% ET_{crop}), were applied via drip irrigation
- Seasonal surfactant treatments were 0 or 10 L /ha
- Each plot split in half to be harvested in two stages to determine total biomass and grain yield.



**Effects of irrigation regimes and water treatments
(with and without surfactant) on ear yield of corn
(Mean 2008 and 2009)**

Evolving technological emphasis to improve crop water productivity



Traditional Adjuvant Technology

Plant Growth Regulators

+Adjuvants

Plant Health Products

+Adjuvants

Transpiration Modifiers

Soil Physics and Hydraulics

Polymers - Synthetic and biological origin

Soil Surfactants