

Midwest Soil Improvement Symposium:

... — 2012 — ...

Research and Practical Insights into Using Gypsum

Current Research Activities for Agricultural Uses of Gypsum

Dr. H. Allen Torbert

*Research Leader, National Soil Dynamics Laboratory
USDA- Agricultural Research Service*





Current Research Activities for Agricultural Uses of Gypsum

Allen Torbert

USDA-Agriculture Research Service
National Soil Dynamics Laboratory

Benefits of Gypsum

- Improve soil properties
 - Improve water infiltration
 - Control soil erosion and crusting
 - Nutrient soil for crops (Ca and S)
 - Alleviate the effects of subsoil acidity (Al Toxicity)
- Reduce contaminates in water runoff.

ARS Multi Location Gypsum study

Use of FGD Gypsum to Improve Crop and Forage Production and reduce P loss on Erodible Soils of the South

Research Goals

- Establish rates of FGD gypsum and poultry litter
- Document improvements in water quality
- Develop guidelines for use of FGD gypsum



USDA-ARS J. Phil Campbell Sr. Natural Resource
Conservation Center, Watkinsville, GA

Harry Schomberg - Pasture

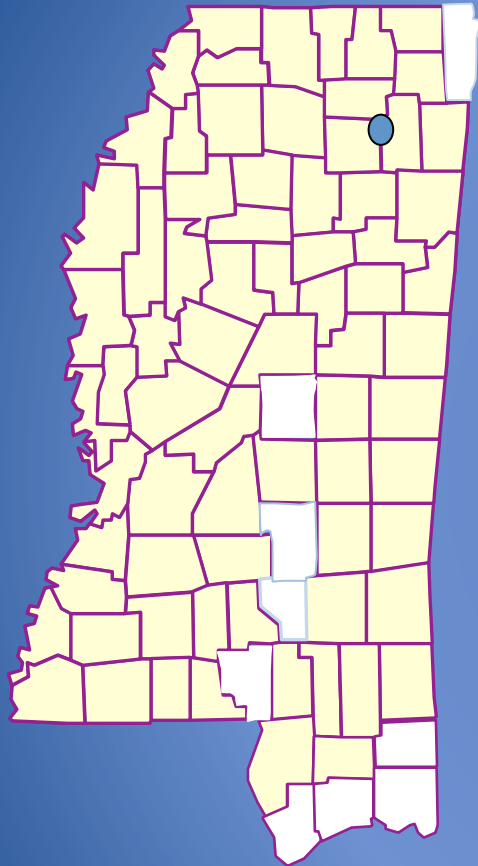
USDA-ARS National Soil Dynamics Laboratory,
Auburn, AL

Dexter Watts - Pasture

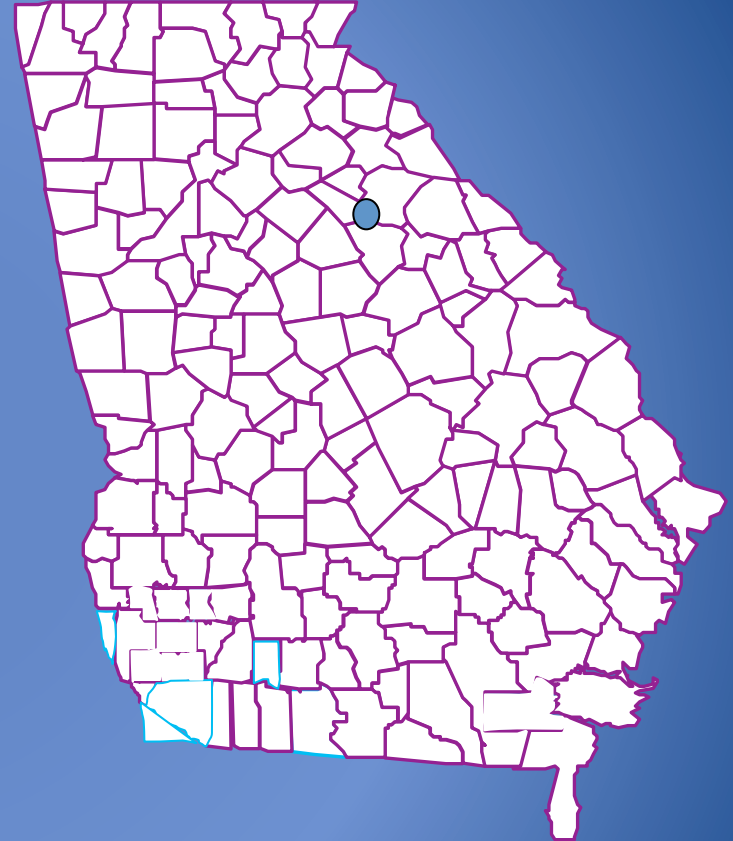
USDA-ARS National Sedimentation Laboratory,
Oxford, MS

Martin Locke – Row Cropping Systems

Oxford, MS

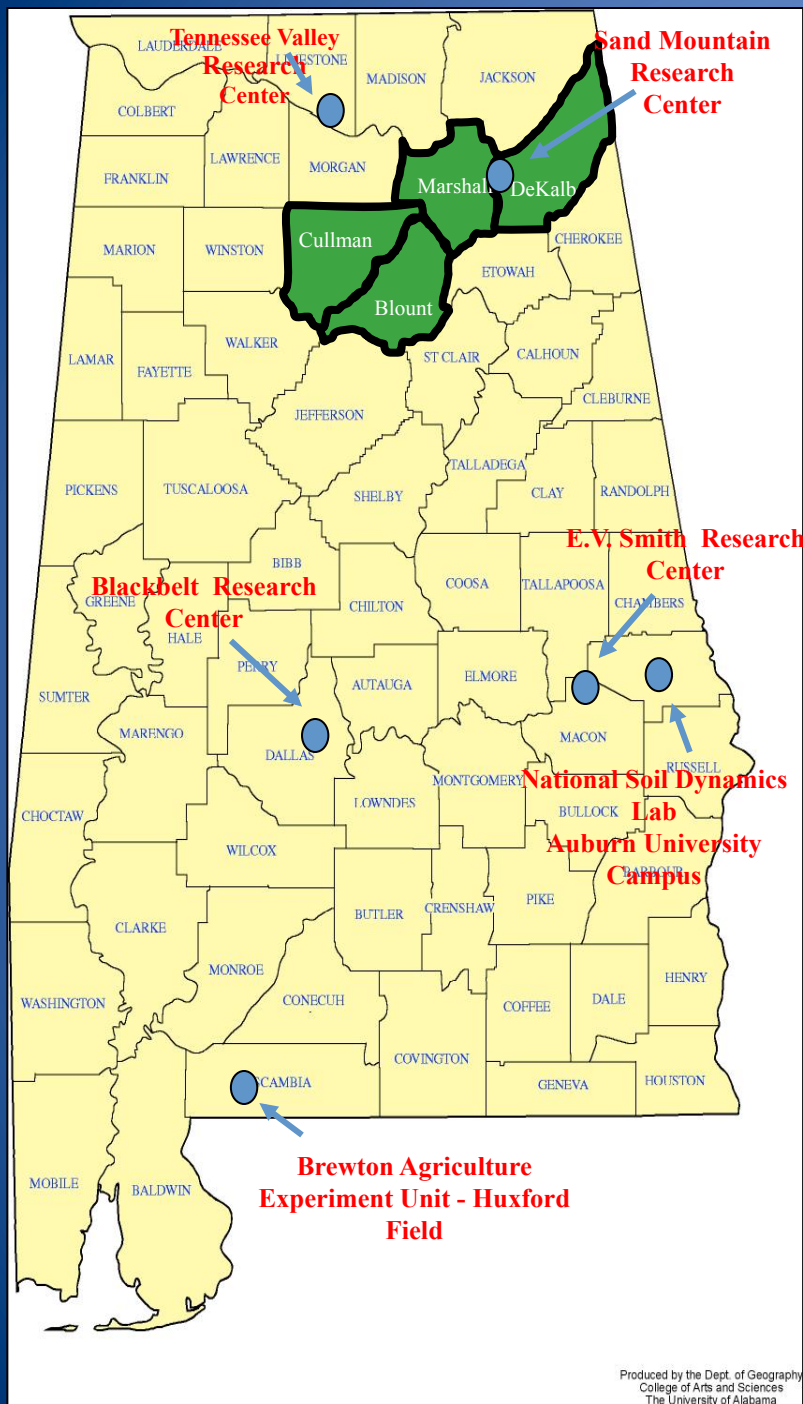


Watkinsville, GA



Verona, MS

Milam, TN



- National Soil Dynamics Lab - Auburn University campus
- EV Smith Experiment Station
- Blackbelt Research Center
- Sand Mountain Research Center
- Brewton Research Unit - Huxford Field
- Tennessee Valley Experiment Station

FGD-Gypsum & Poultry Litter

Poultry Litter (tons/acre)

Gypsum (tons/acre)

	0	2	4	6
0	0-0	0-2	0-4	0-6
1	1-0	1-2	1-4	1-6
2	2-0	2-2	2-4	2-6
4	4-0	4-2	4-4	4-6

Watkinsville

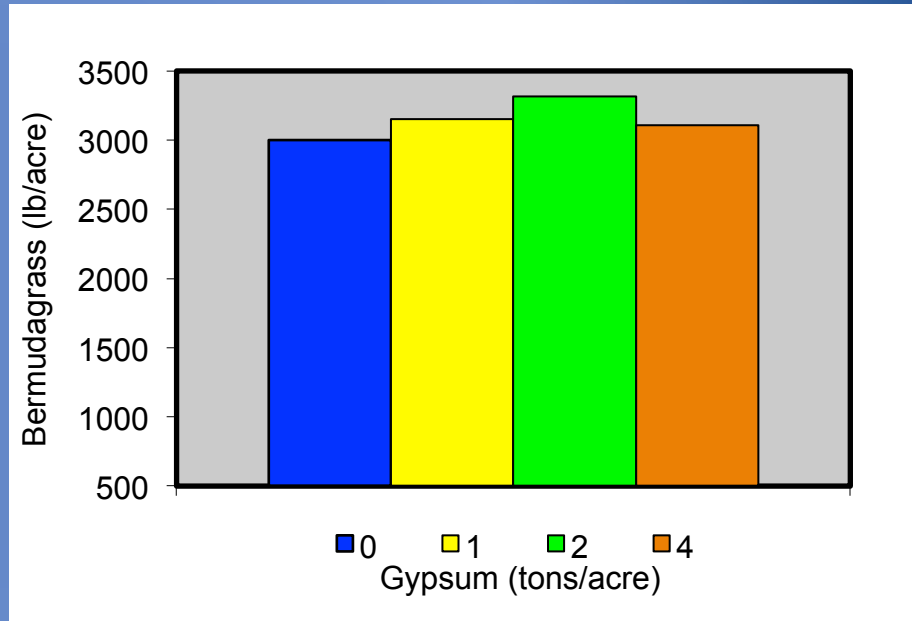
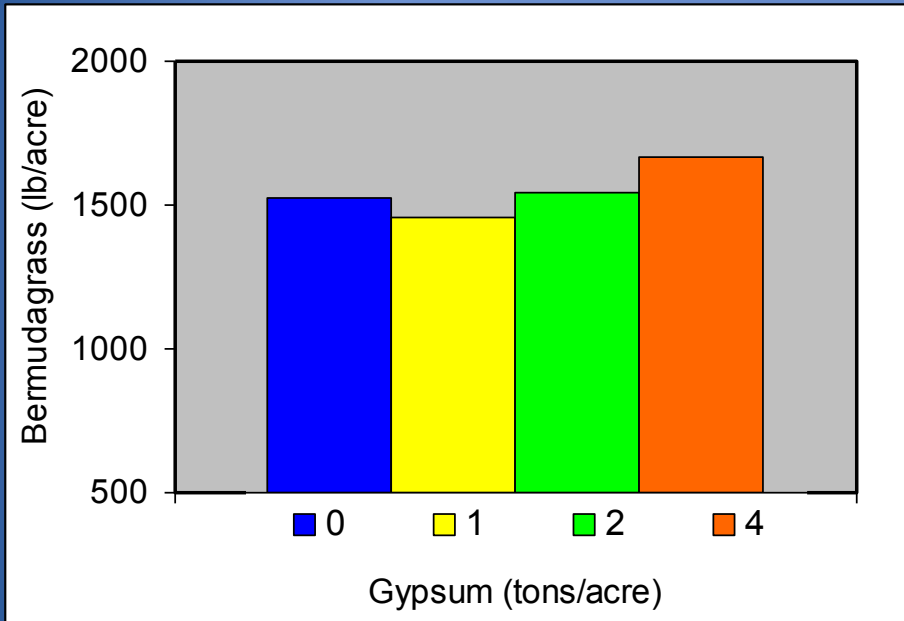


ARS Site

EV Smith Experiment Station



Yield Average



Bermudagrass

Water Quality

- What is quality of water in the U.S.
 - * 45% of river miles are impaired
 - * 47% of lake acres,
 - * 32% of estuarine water is impaired.
- Agriculture is considered to be one of the major contributors to water quality
- Phosphorus loss from agriculture
- Poultry Industry
 - Improper disposal of waste from poultry industry





Gypsum Interaction with Soluble P

- Formation of an insoluble Ca-phosphate complex
- Insoluble hydroxyapatite and fluorapatite

Rainfall Simulations



FGD-Gypsum & Poultry Litter

Poultry Litter (tons/acre)

Gypsum (tons/acre)

	0	2	4	6
0	0-0	0-2	0-4	0-6
1	1-0	1-2	1-4	1-6
2	2-0	2-2	2-4	2-6
4	4-0	4-2	4-4	4-6



Time samples - 0, 10, 20, 30, 40, 50, 60

Cumulative samples

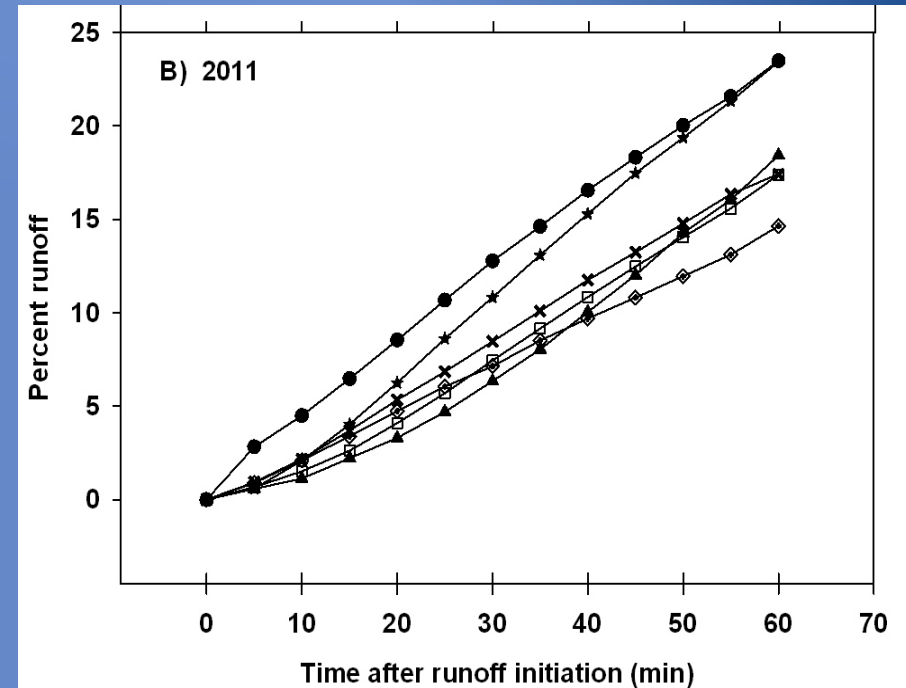
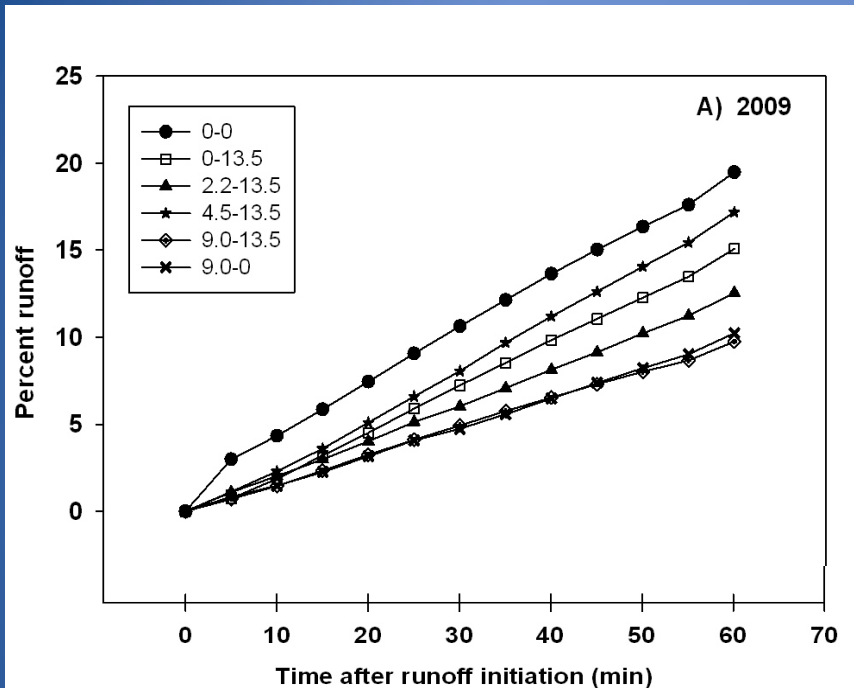
Unfiltered – Total nutrient

Filtered - Dissolved

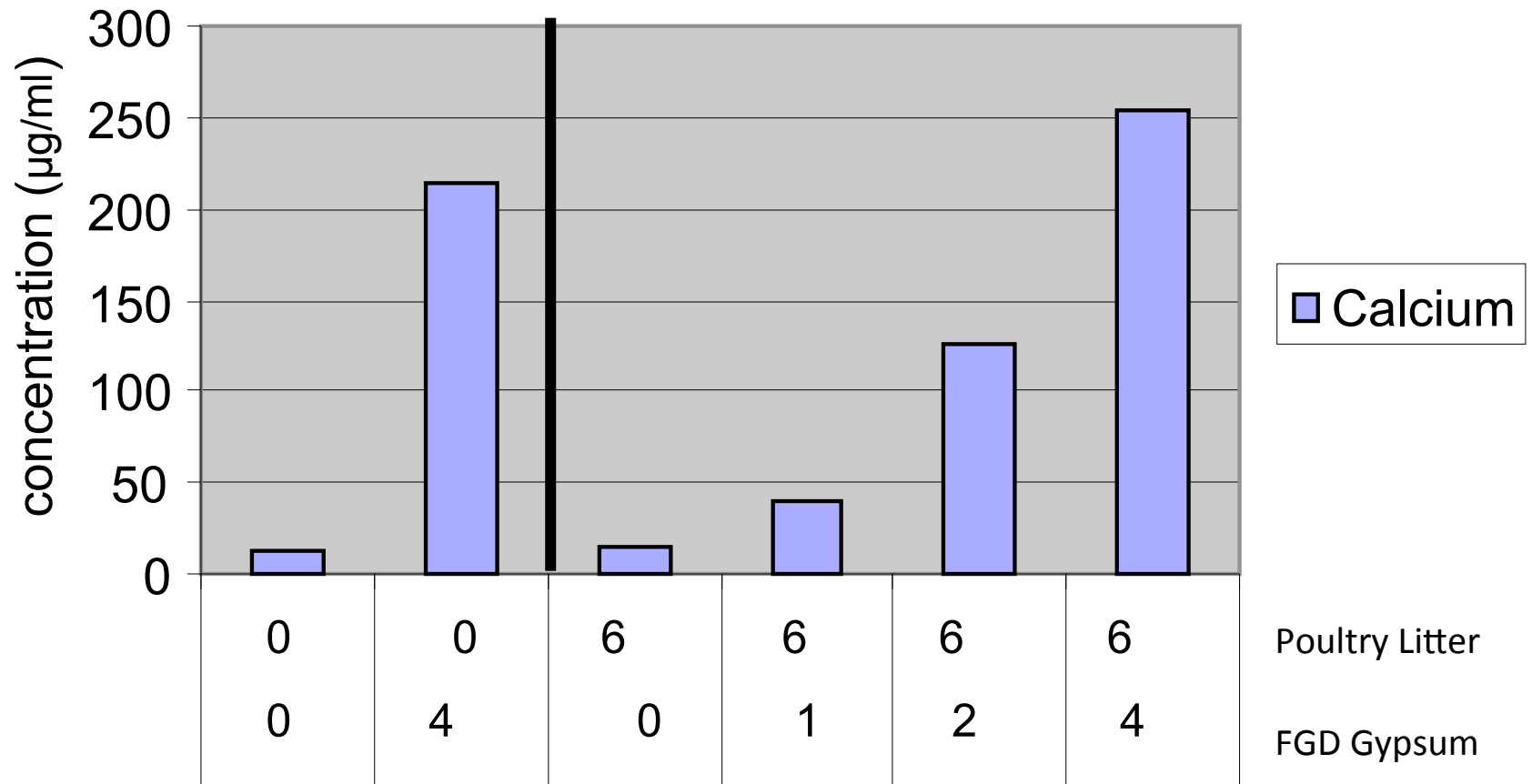
Runoff



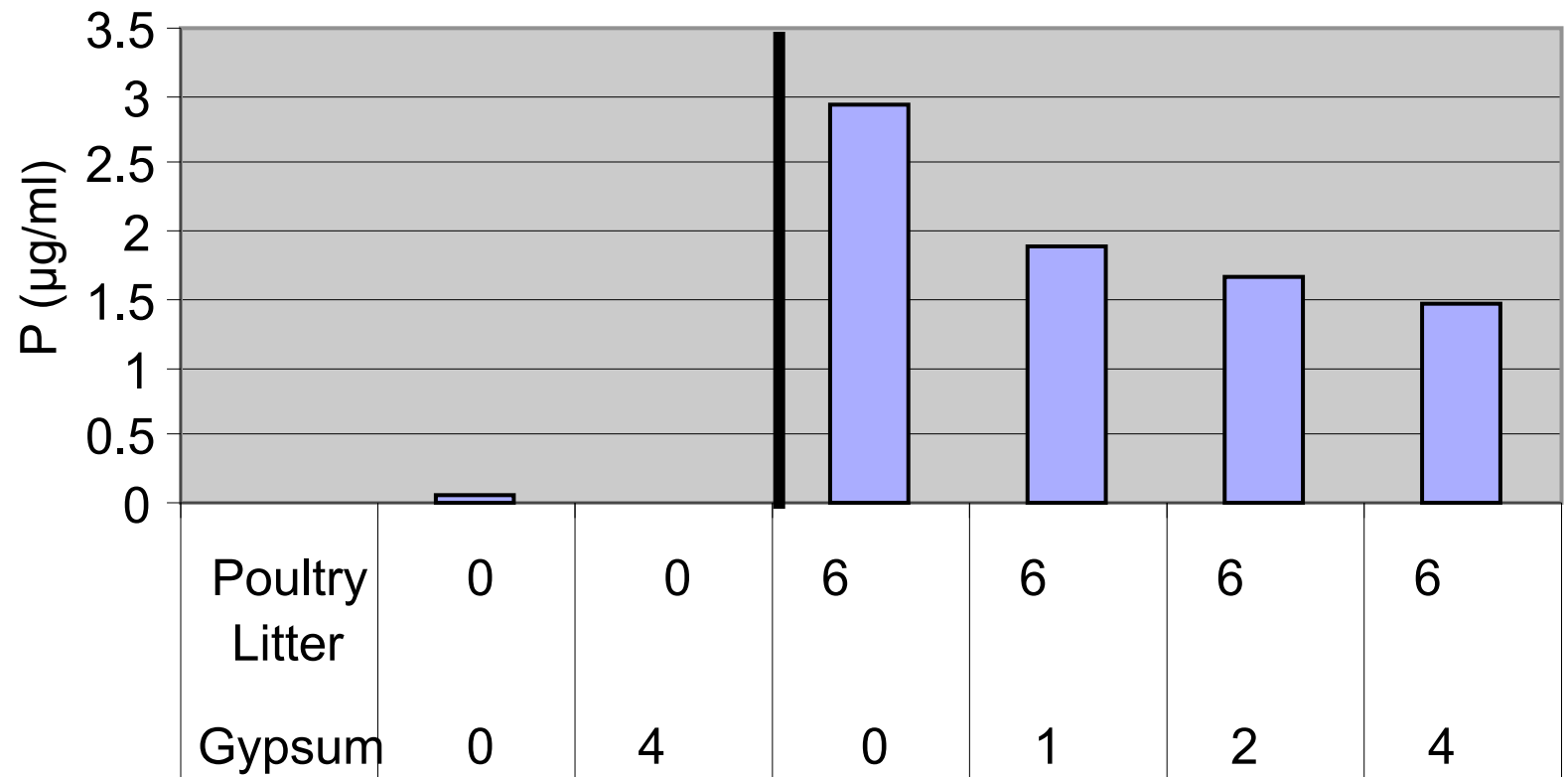
Runoff as % of Rainfall



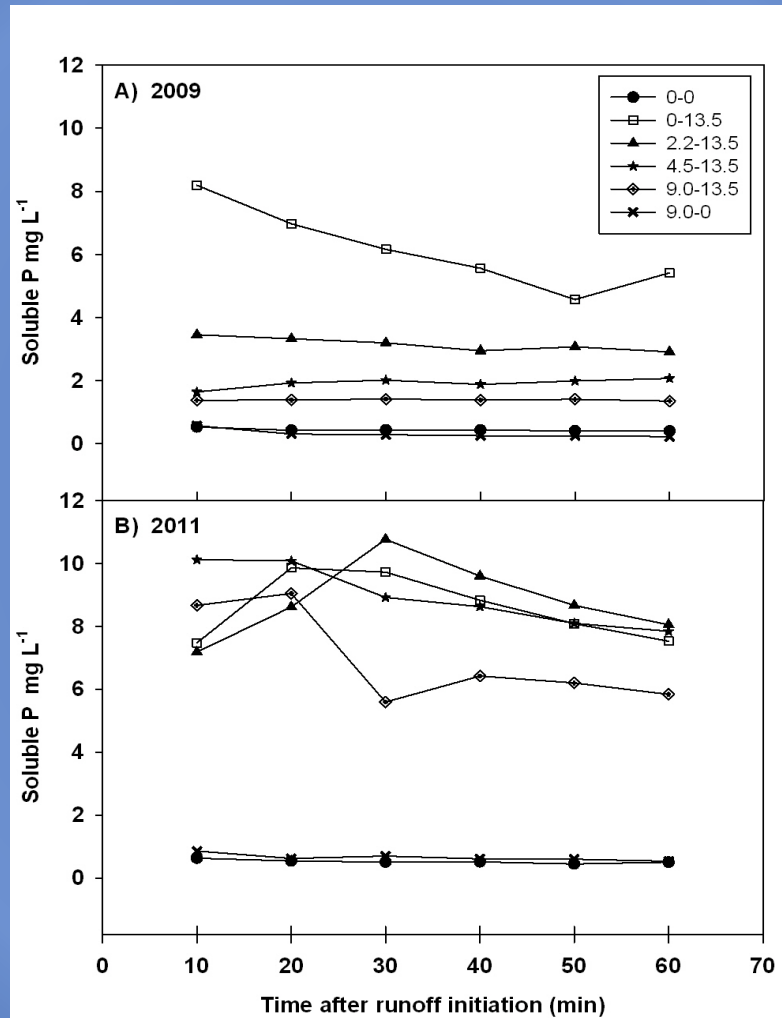
Runoff



Soluble P in Runoff

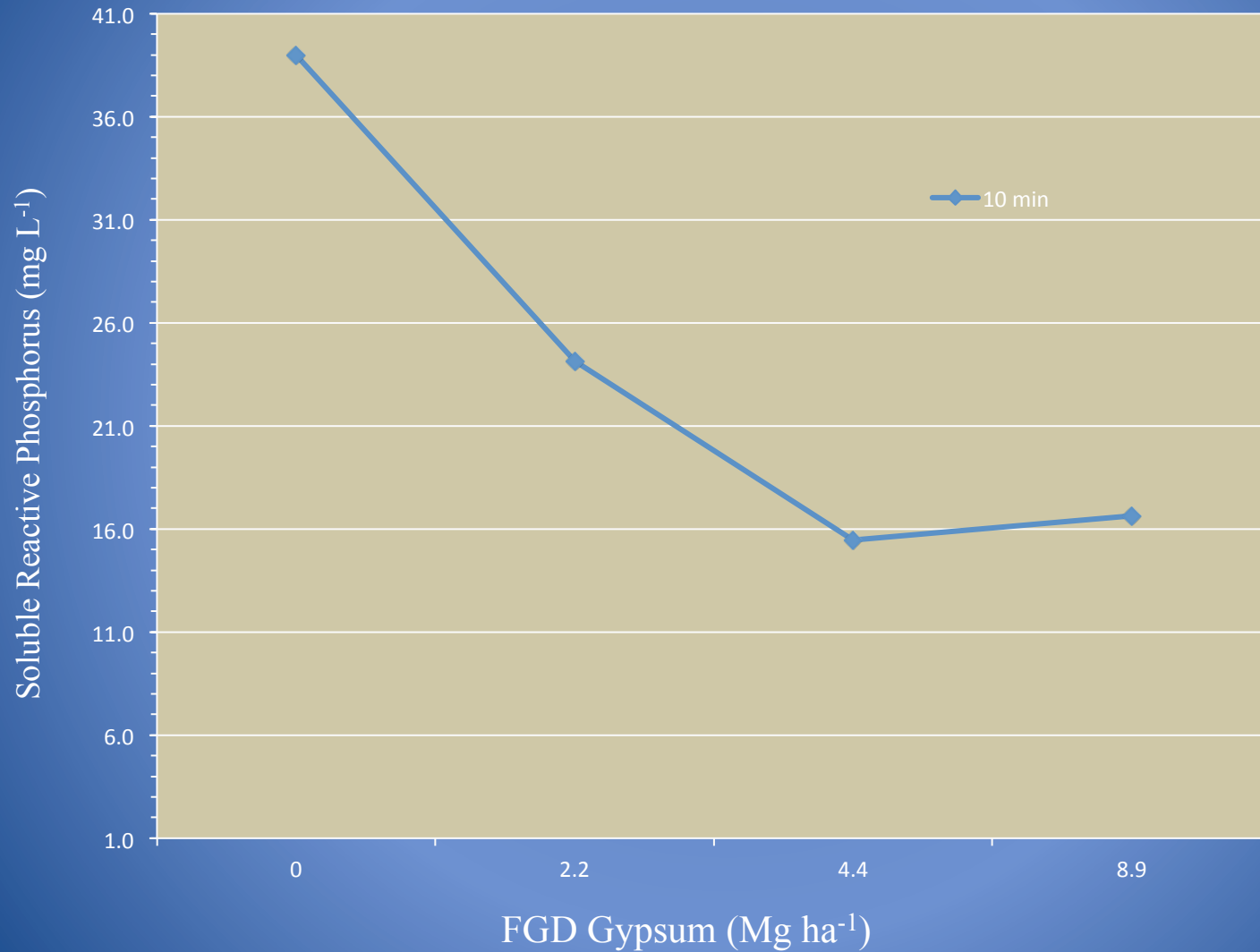


Soluble P



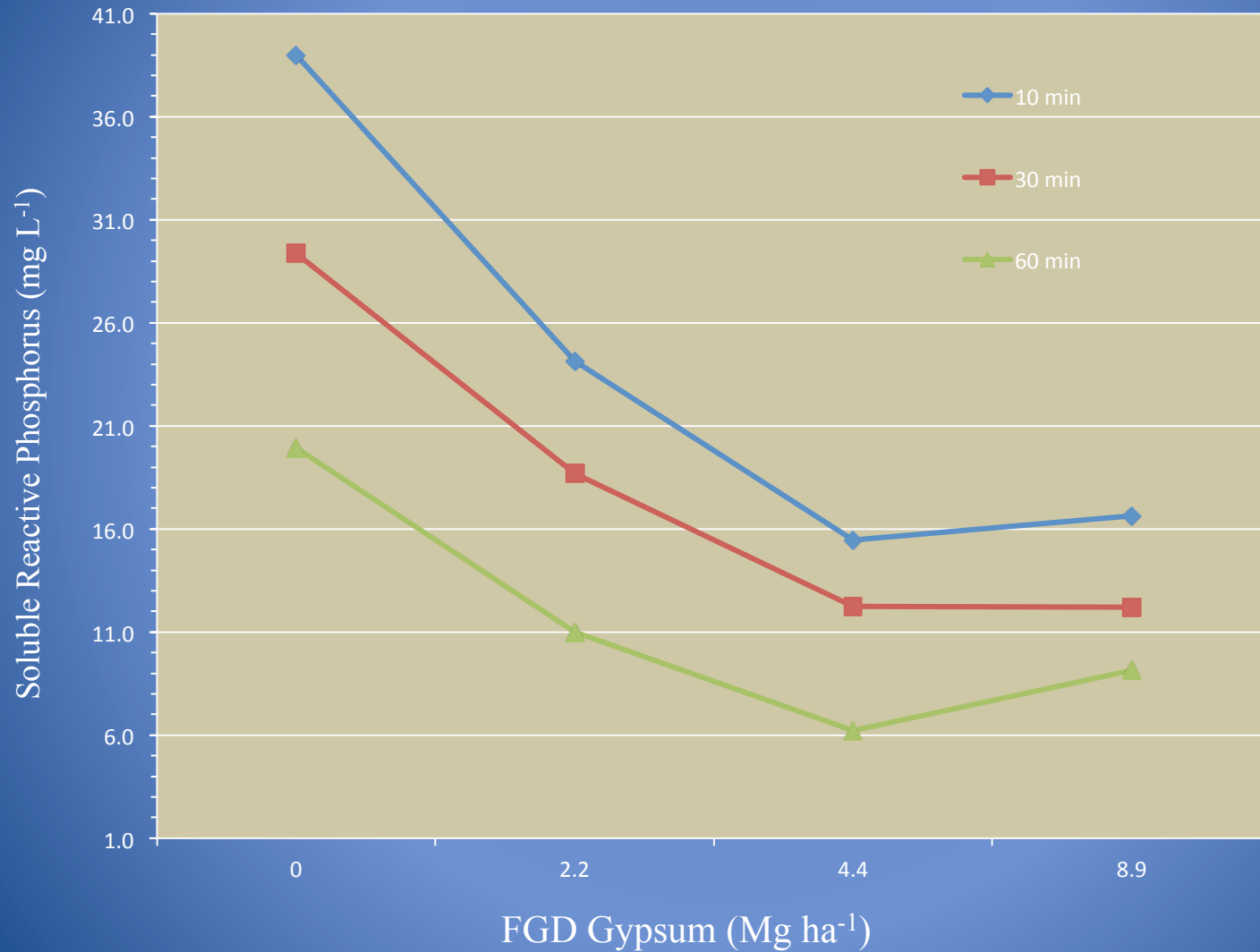
Initial Runoff

Worst Case



Initial Runoff

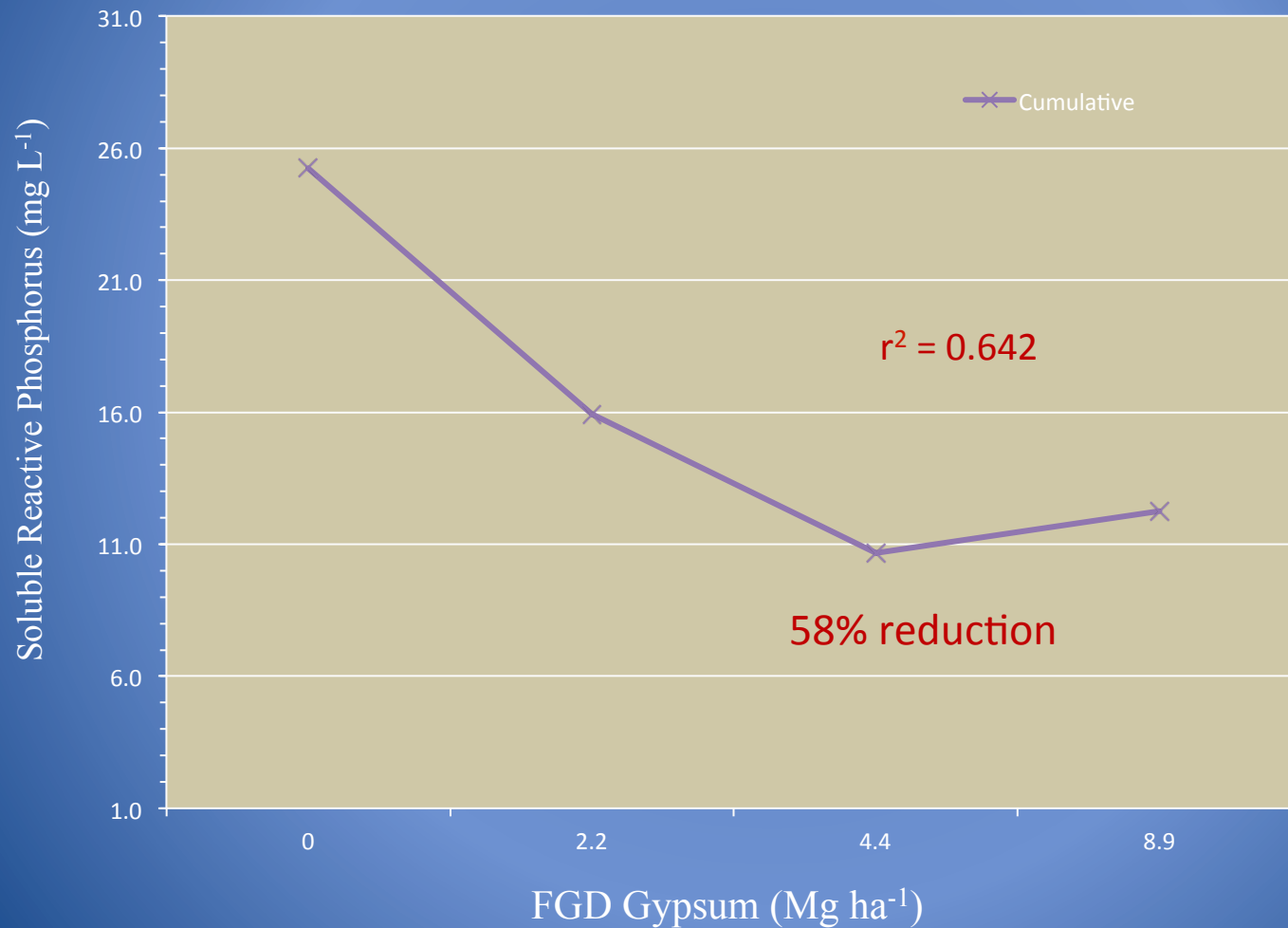
Worst Case



Initial Runoff

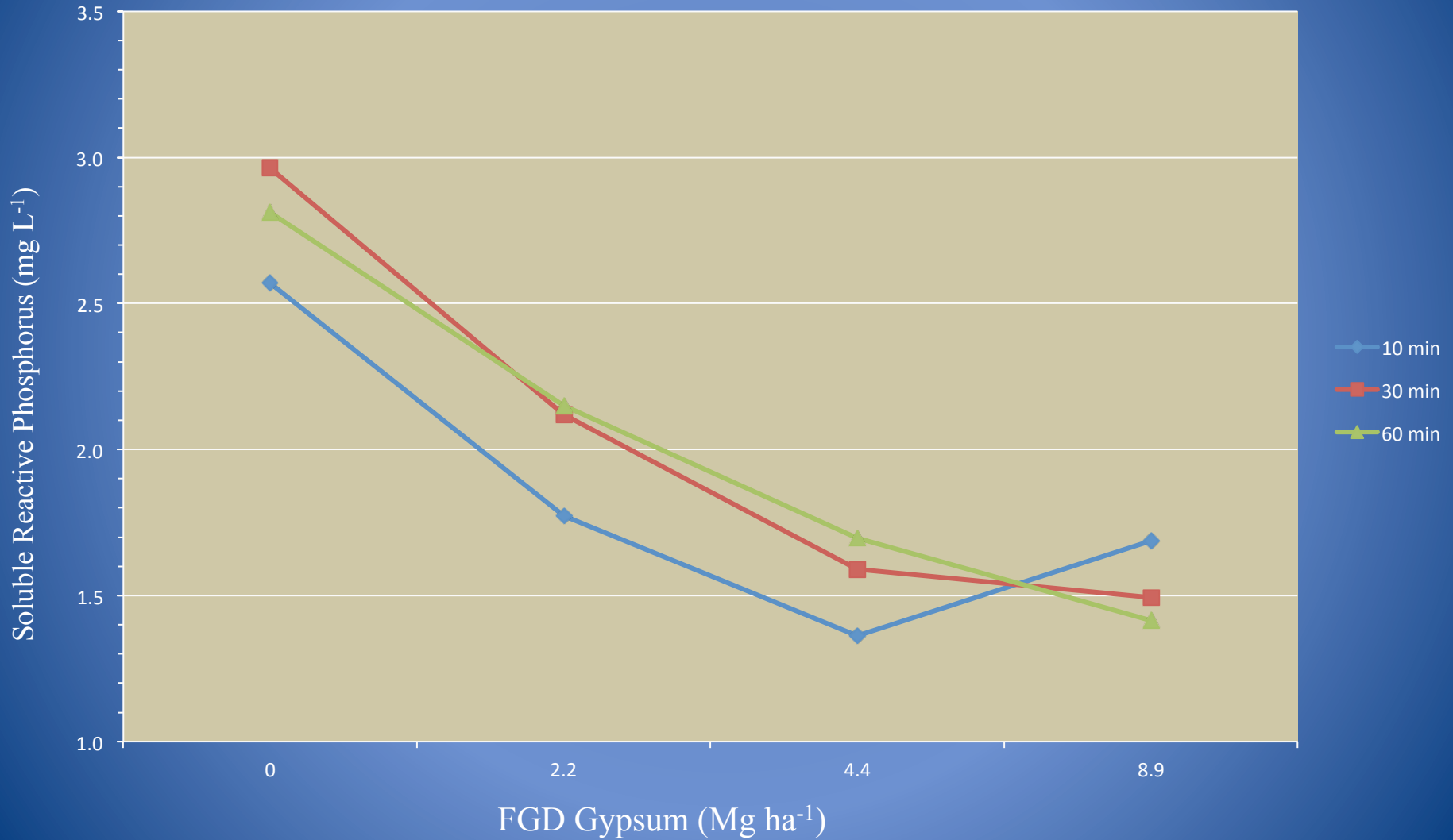
Worst Case

Cumulative



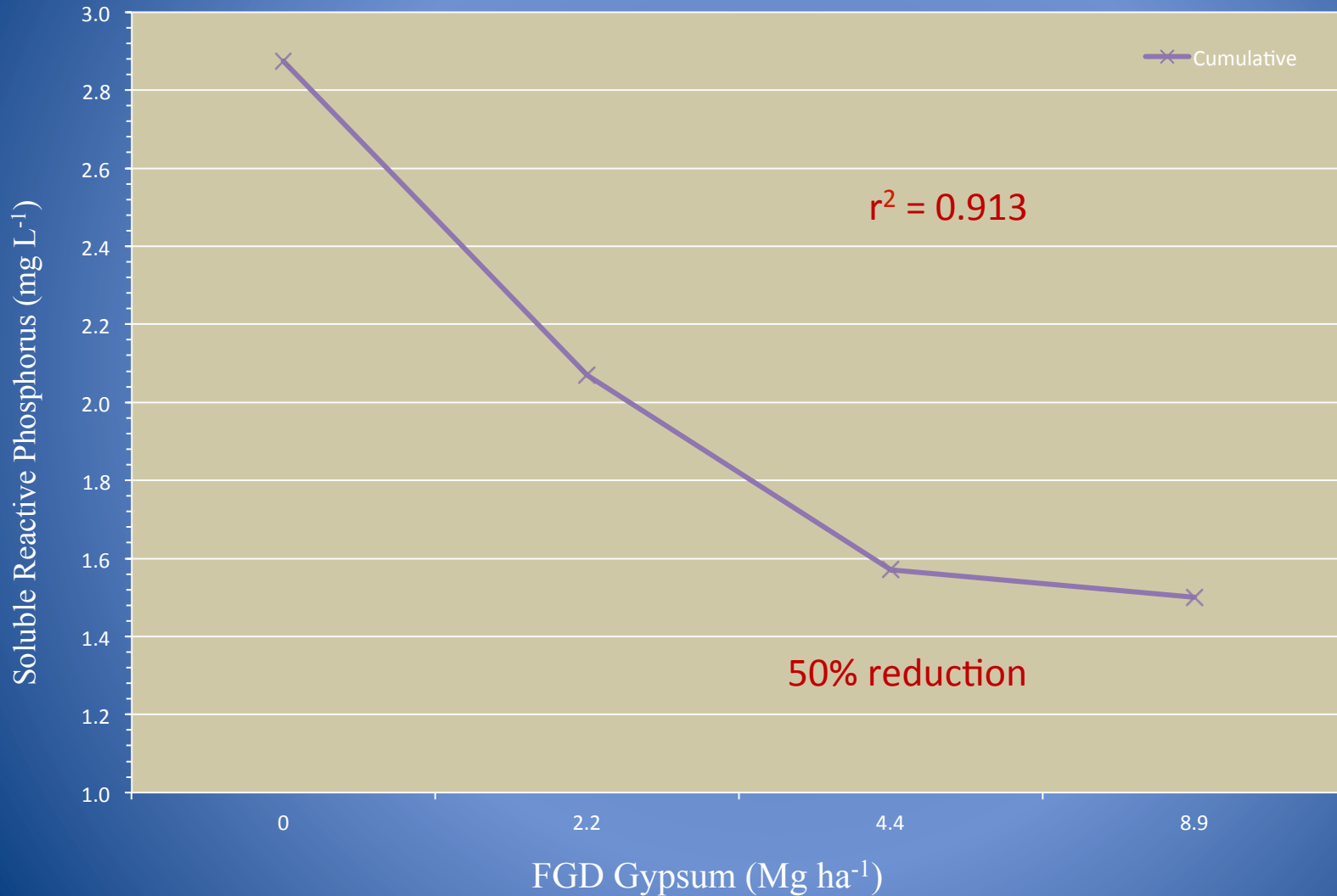
Six Weeks Runoff

After 5 inches

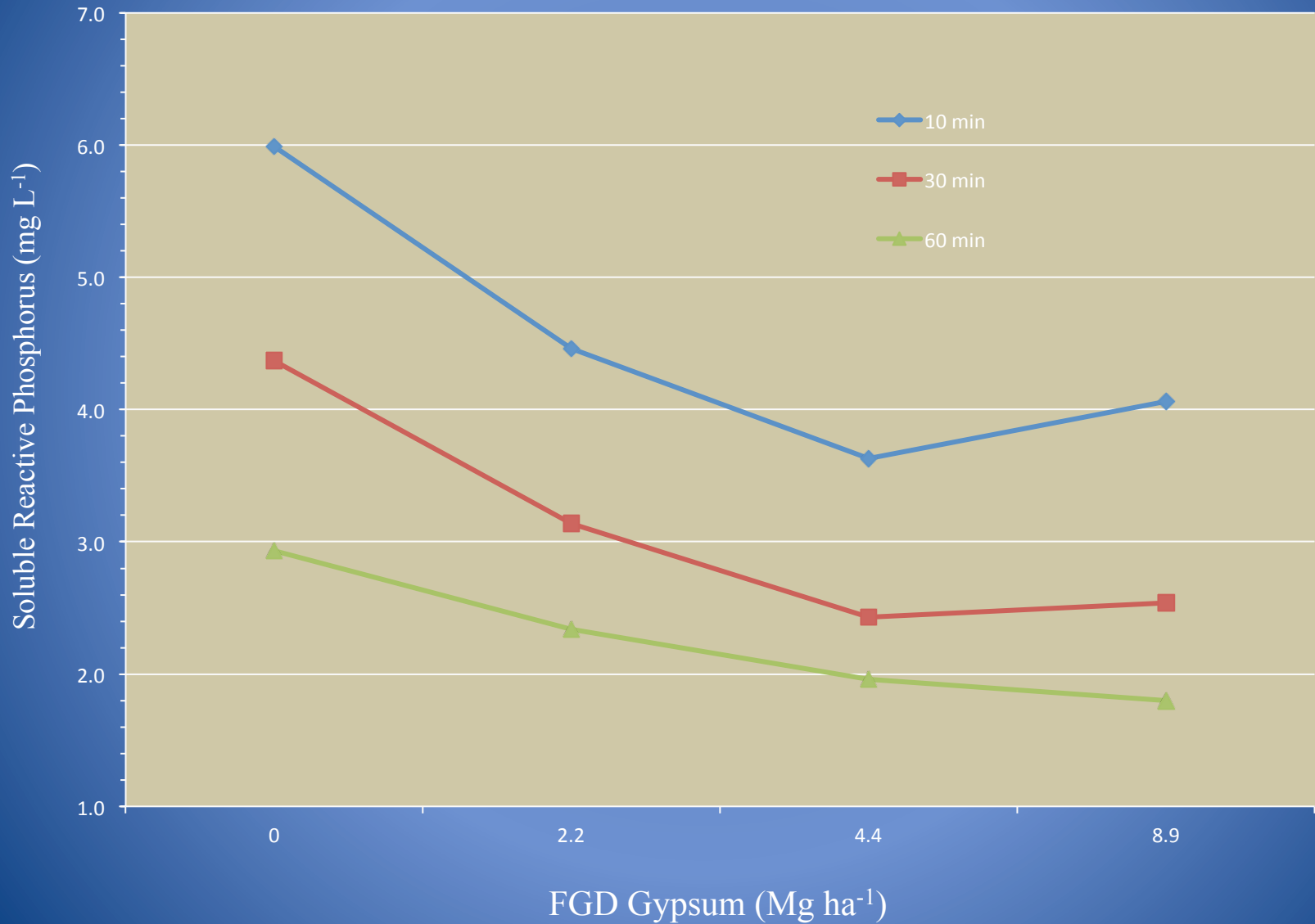


Six Weeks Runoff

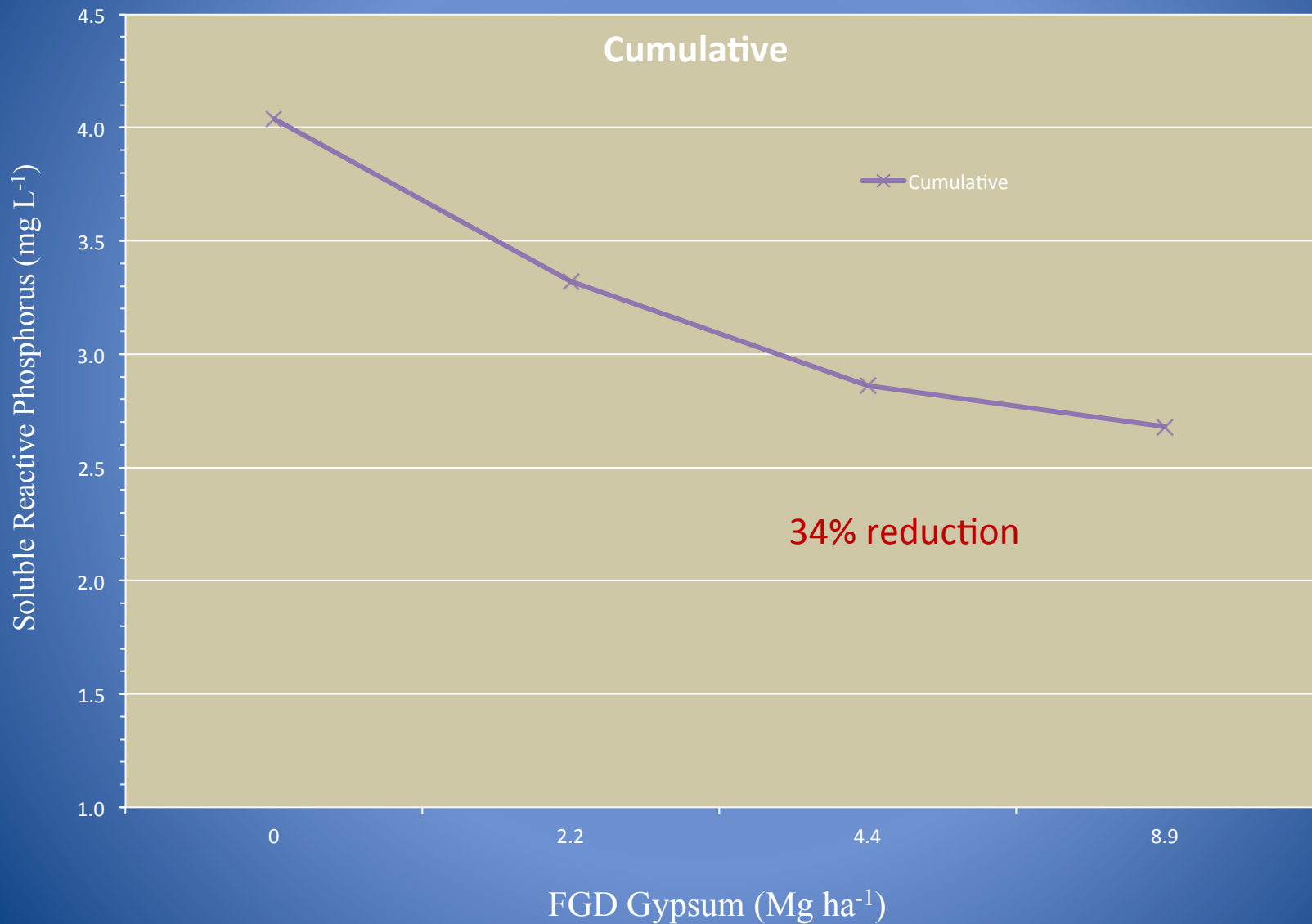
After 5 inches



End of Season Runoff



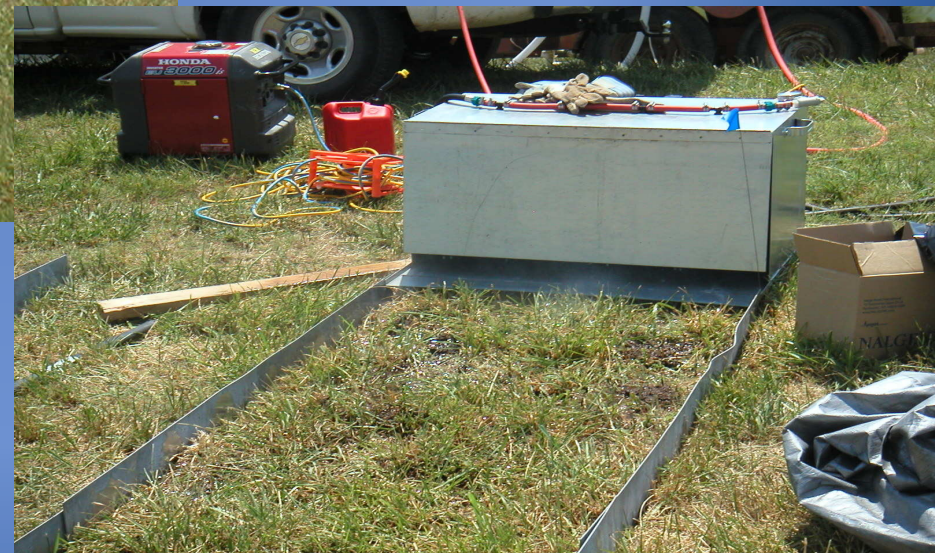
End of Season Runoff



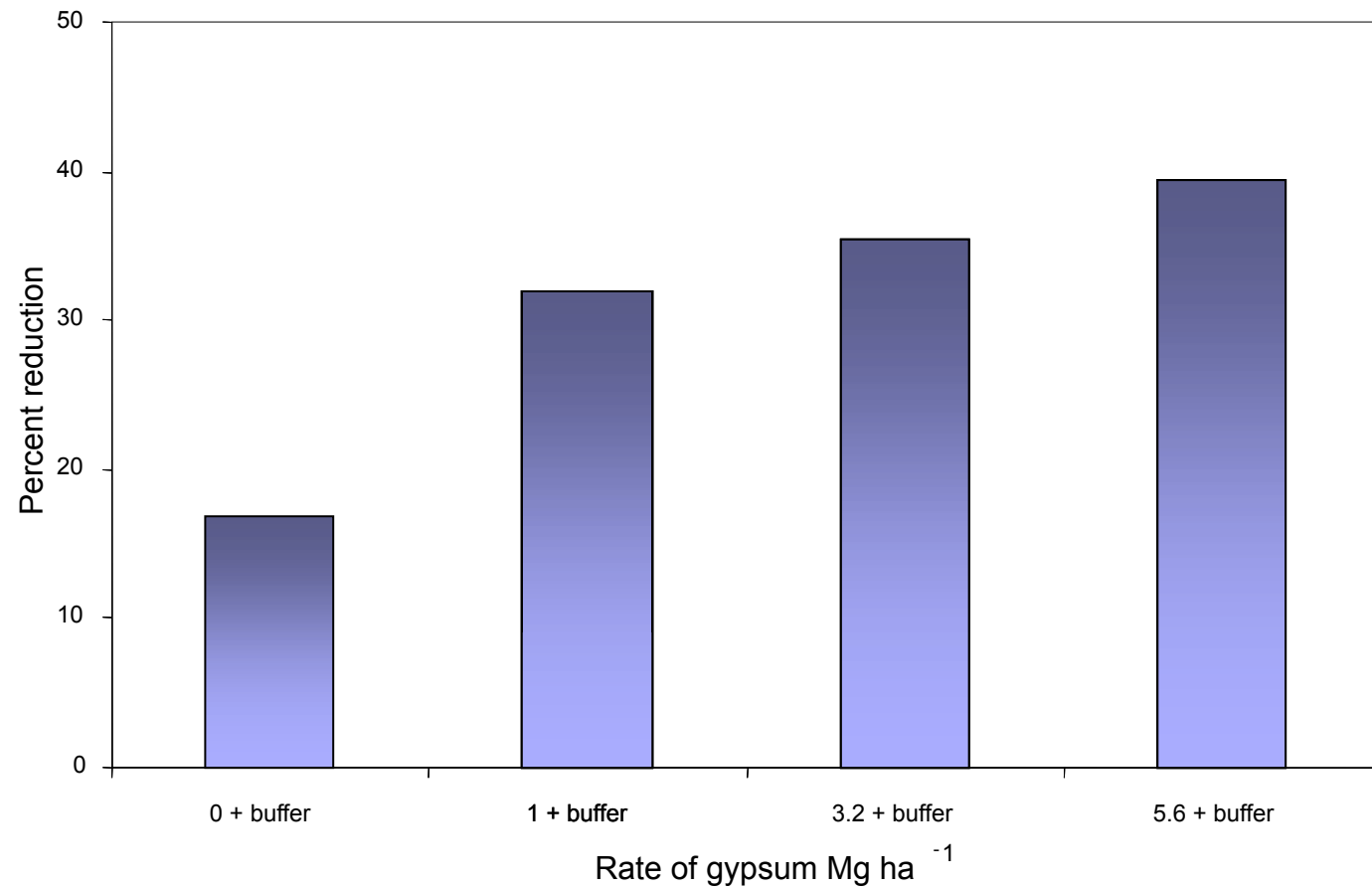
Gypsum Run-over



**Watts D.B., and H. A. Torbert. 2009.
Impact of Gypsum Applied to Buffer Strips
on Reducing Soluble P in Surface Water
Runoff. J. Environ. Qual. 38:**

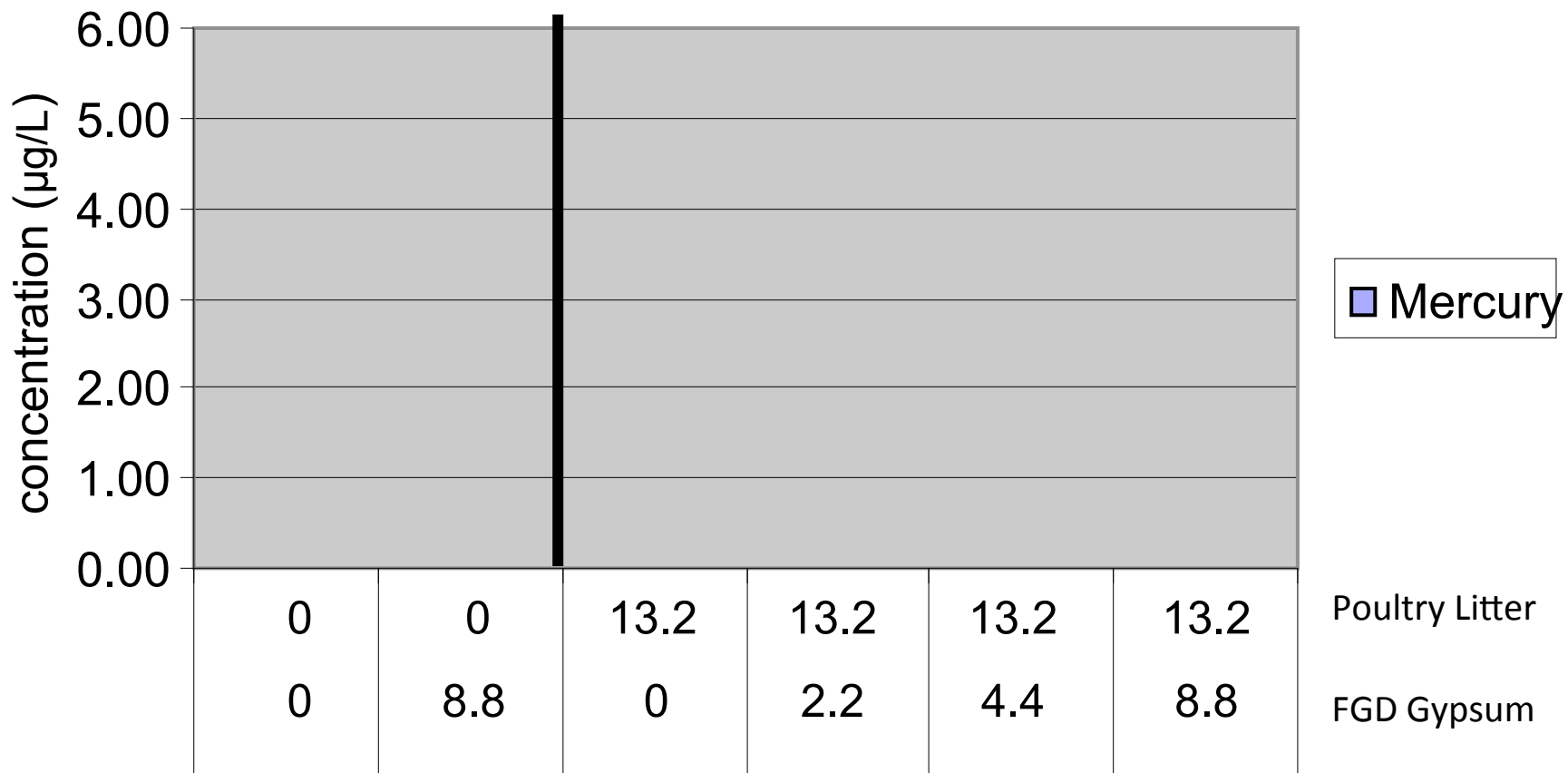


Percent soluble P reduction



Runoff

<0.50 µg/L



Not Detected

Arsenic

Aluminum

Antimony

Barium

Beryllium

Cadmium

Chromium

Hexavalent Chromium

Cobalt

Lead

Nickel

Selenium

Silver

Thallium

Vanadium

$\approx <50 \mu\text{g/L}$

Not Detected

Dissolved Arsenic

Dissolved Aluminum

Dissolved Antimony

Dissolved Barium

Dissolved Beryllium

Dissolved Cadmium

Dissolved Chromium

Dissolved Cobalt

Dissolved Copper

Dissolved Lead

Dissolved Potassium

Dissolved Selenium

Dissolved Silver

Dissolved Sodium

Dissolved Thallium

Dissolved Vanadium

Dissolved Zinc

Kitchen Sink

$\approx <50 \mu\text{g/L}$

USDA-ARS
National Sedimentation Lab,
Oxford, MS



Verona, MS

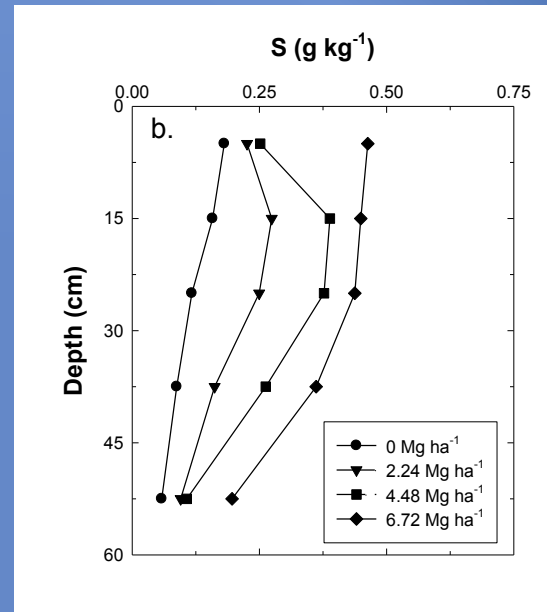
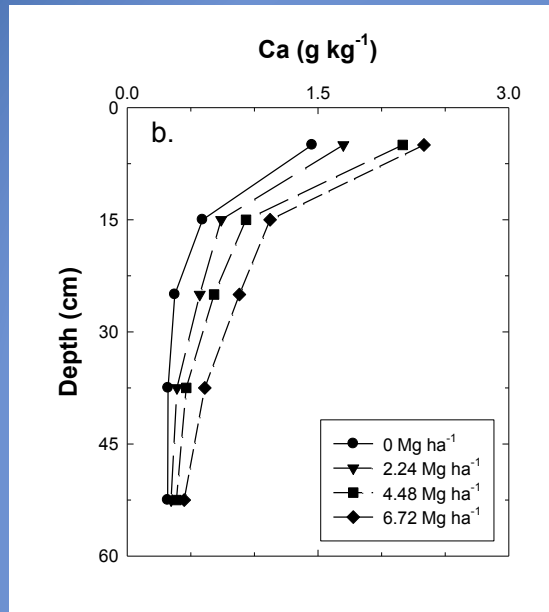
Cotton and Soybeans



Milan, TN

Conventional tillage vs. No-tillage

Results



Comments: Calcium and sulfur distributions with soil depth indicate that three consecutive years of surface applied FGD gypsum amendments on no-till cotton have resulted in significant increases in these essential plant nutrients at depth.

Note: 0, 2.24, 4.48, and 6.72 Mg ha^{-1} correspond to 0, 1, 2, and 3 tons/acre.

Soil Physical Characterization



Soil penetration resistance, 2012 Milan, TN

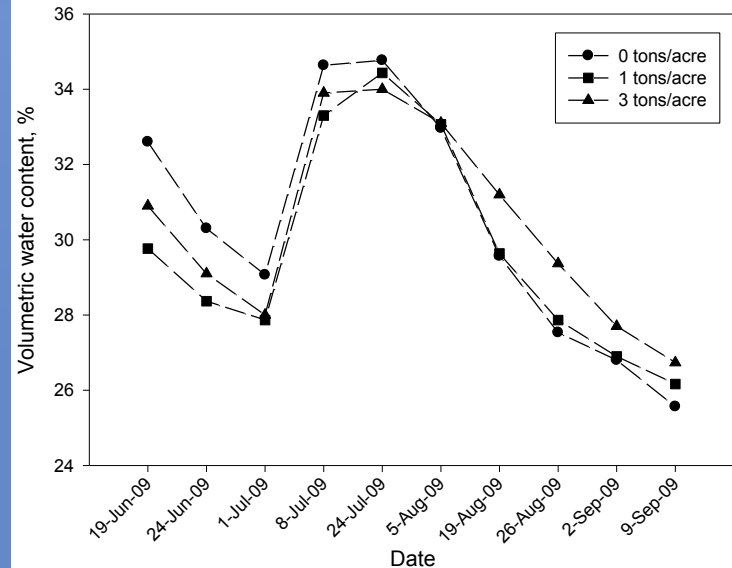
- Cone penetrometer measured integrated total force required to reach a 12-inch depth
- Crop row and middle of row (wheel track and non-wheel track)
- In all row positions, resistance tended to decrease in plots treated with FGD gypsum,

Tillage	FGD gypsum rate	Non-wheel track middle	Crop Row	Wheel track middle
	tons/acre	----- kPa X 10 ⁻³ -----		
Conventional	0	79.4	76.0	94.8
	1	71.2	73.3	91.3
	2	68.7	75.0	84.2
	3	72.2	71.3	89.0
	5	73.4	69.9	86.4
No-till	0	80.8	72.5	90.6
	1	68.4	68.9	83.0
	2	84.0	75.5	92.3
	3	71.4	71.4	84.3
	5	79.1	70.1	88.1

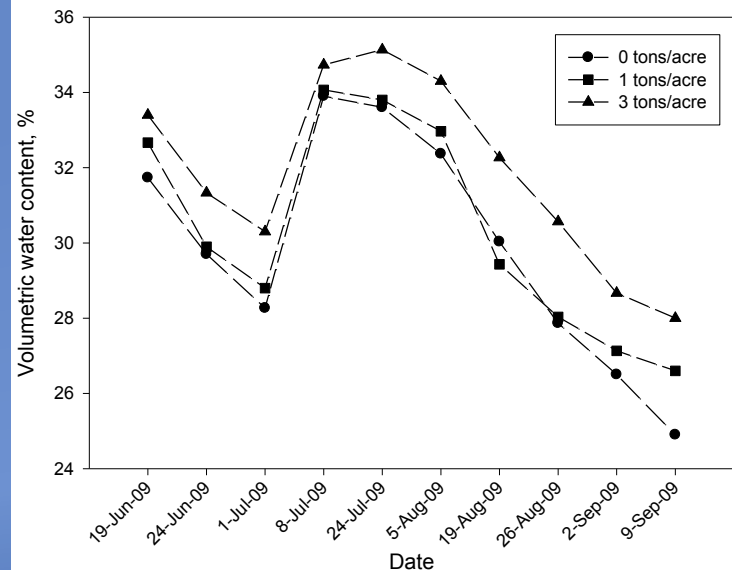
Soil water content during the 2009 growing season Verona, MS

- Water content was measured with TDR only in 2009
- CT plots showed little difference until end of the growing season, when 3 tons/acre FGD held more water
- NT showed a more consistent advantage for the 3 tons/acre FGD treatment, with the difference starting earlier in the growing season
- Slightly higher soybean yields in NT may have resulted from the increased moisture

Conventional till, 0-30 cm

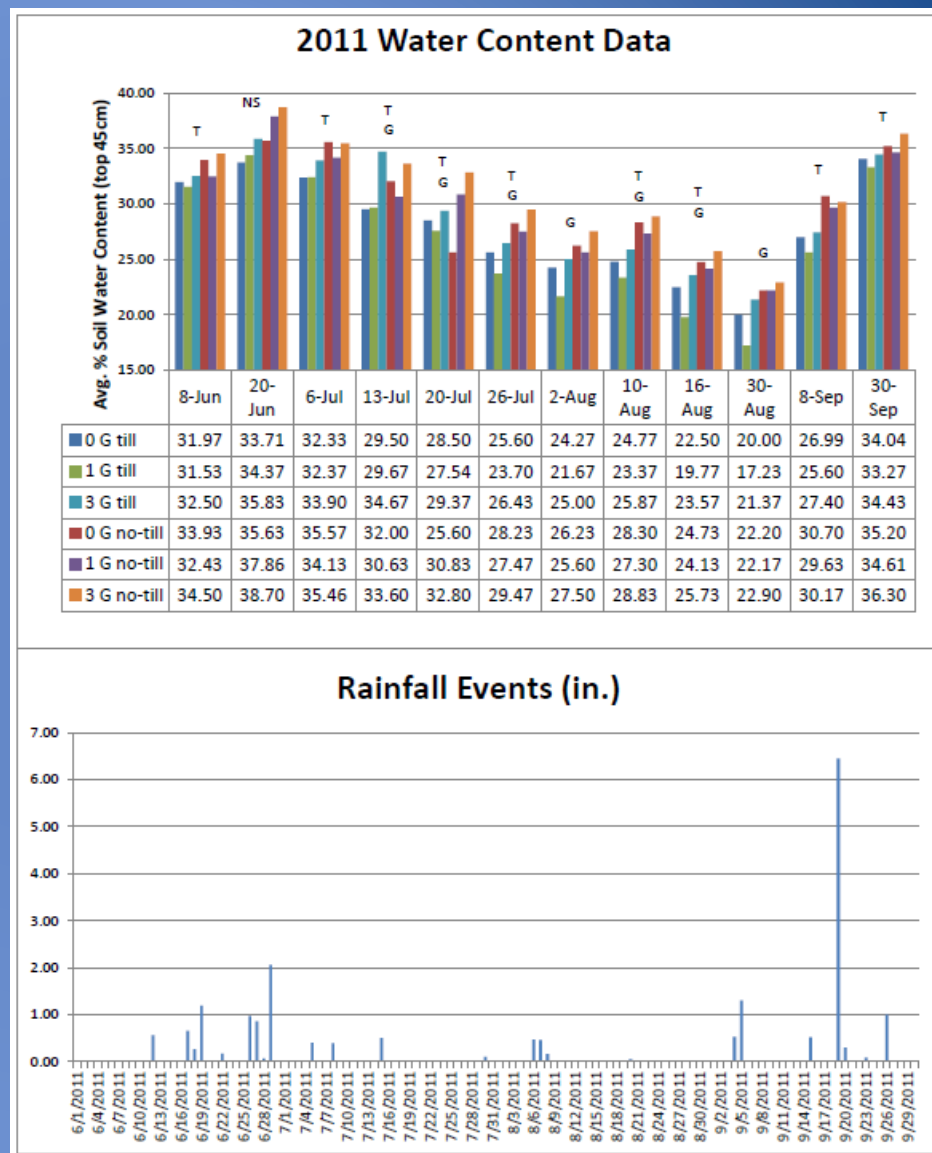


No-till, 0-30 cm



Soil water content, Milan, TN

- TDR soil water content, 2011
- Rainfall and mean volumetric soil water content for the top 45 cm as affected by tillage and gypsum
- With exception of two dates, 3 tons/acre NT plots consistently had higher soil moisture
- NT cotton yields were higher in 2011



Martin Locke - unpublished data



- Tennessee Valley Experiment Station



Infiltrrometer



Cornell
Infiltrrometer



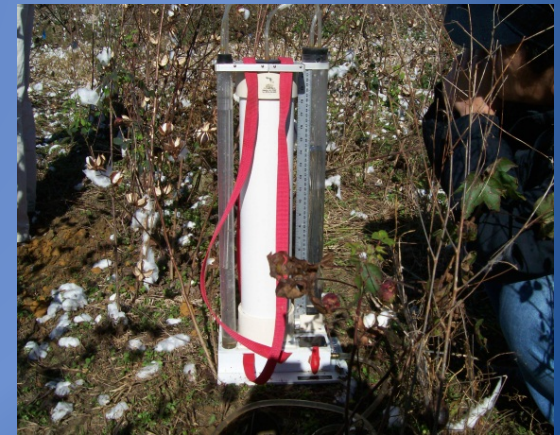
E. C.



Penitrometer



Porosity



Porosity

Conclusion

- Gypsum can improve soil physical properties
- Improve aggregation
- Increase Water Infiltration
- Reduce runoff
- Improve water holding capacity
- Reduce erosion losses and nutrient losses