

# Chemical and Nutritional Properties of FGD Gypsum Improve Production of Corn, Soybeans, and Other Crops

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# Functions of Gypsum in Agriculture

- Ca and S for crop nutrition
- Ameliorate subsoil acidity
  - Increases crop rooting depth
  - Increases water and nutrient uptake at depth
- Improve water infiltration and drainage
- Reduce soil crusting for better seedling emergence
- Ameliorate sodium-affected soils

# Corn on Acid Subsoil South Africa

- 11 treatments including conventional liming (10 Mg/ha) and various methods of deep lime incorporation
- Best treatment – 10 Mg/ha gypsum after conventional liming
- For 10 years data, gypsum gave cumulative corn grain yield advantage of 3.8 Mg/ha

# Corn on Acid Subsoil South Africa

- Between 45 and 75 cm depth, gypsum treatment showed:

Increased

exchangeable Ca, Mg  
pH

Decreased

exchangeable Al + H  
percent acid saturation  
extractable NO<sub>3</sub>-N

- Extractable NO<sub>3</sub> in profile (0-90 cm) of gypsum plots averaged 30% of conventional limed plots
- M. Farina, P. Channon, G.R. Thibaud
- Soil Sci. Soc. Am. J. 52:175-180 (1988)
- Soil Sci. Soc. Am. J. 64:646-658 (2000)

# Corn and Alfalfa on Acid Subsoil Georgia

Applying coarse sandy loam

Gypsum rates – Exp. 1 = 35 Mg/ha

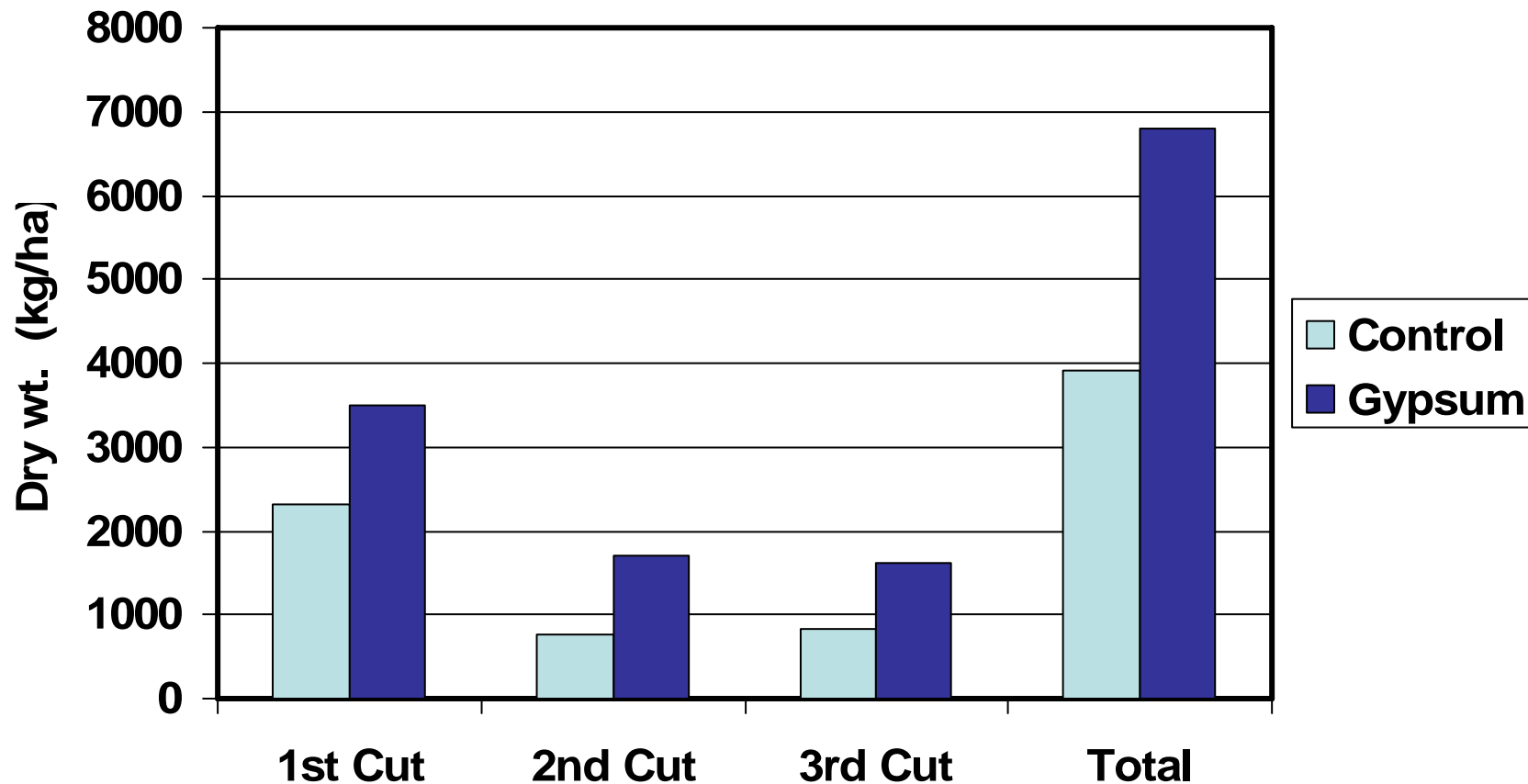
Exp. 2 = 10 Mg/ha

Started in 1981

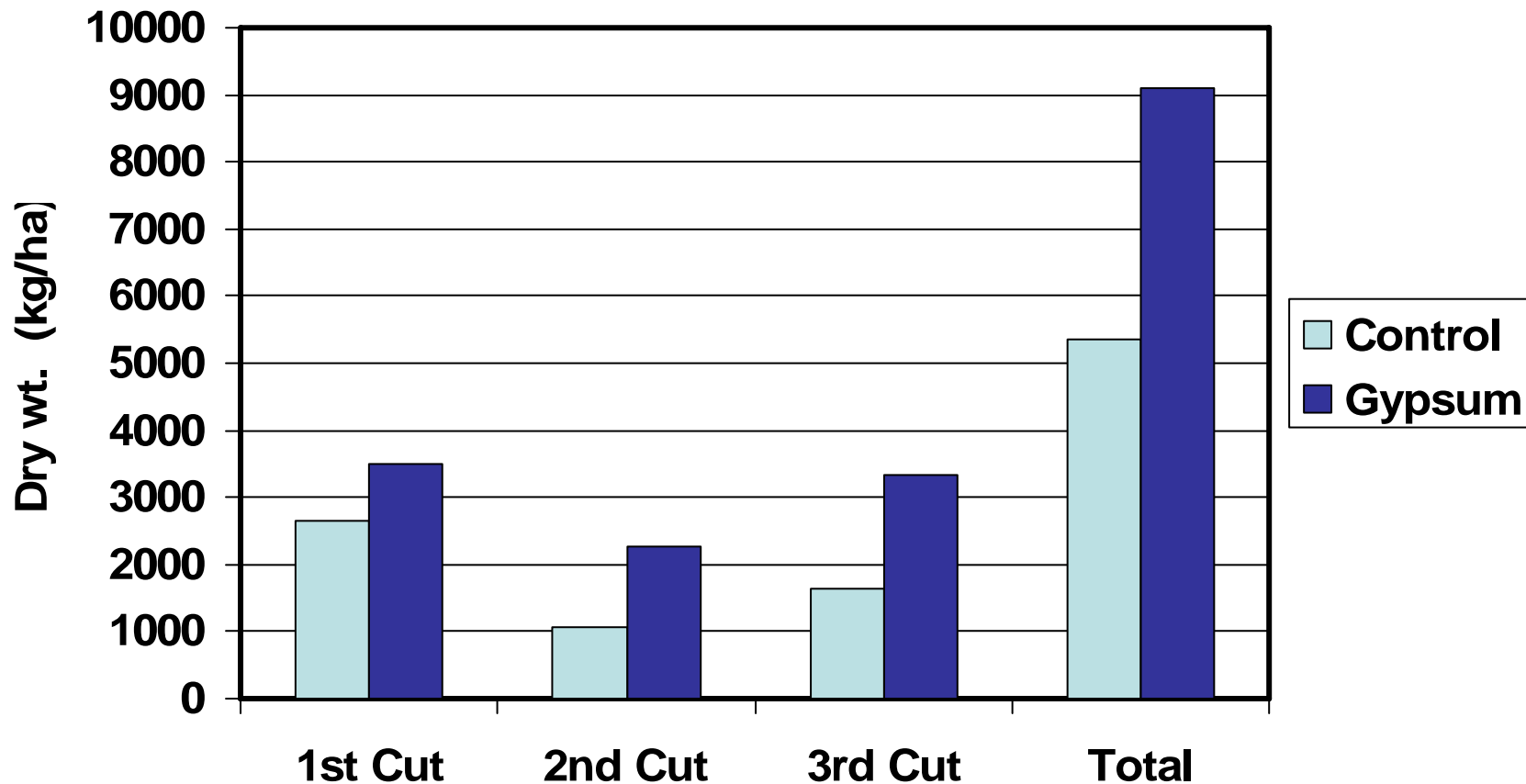
## Corn grain yields

	Exp. 1 (16 yr)	Exp. 2 (15 yr)
Control	6.7	6.6
Gypsum	10.1	8.5

# Alfalfa Yield on Acid Subsoil Exp. 1 (Georgia) - 17 yr.



# Alfalfa Yield on Acid Subsoil Exp. 2 (Georgia) - 16 yr.



# Corn and Alfalfa on Acid Subsoil Georgia

M. Thoma, M.E. Sumner, G. Weeks, M.  
Saigusa

Soil Sci. Soc. Am. J. 63:891-895 (1999)

# Corn and N Uptake in Brazil

- Dark red latosol (Typic Haplustox)
- 6000 kg/ha  $\text{CaSO}_4 \cdot 1/2 \text{H}_2\text{O}$  (CS)

Total N in grain and stover (kg/ha)

0 CS	91
6000 CS	135

K.D. Richey, C.M. Feldhake, R.B. Clark, D.M.G. Sousa  
Agricultural Utilization of Urban and Industrial By-Products.  
ASA Spec. Publication Number 58

# Corn and N Uptake in Brazil

- Increased corn N uptake due to:
  - Higher N concentration in the plants
  - Higher biomass production
- Increased corn N uptake = decrease of 48 kg/ha in extractable N in the soil profile
- “the denser root system in the CS treatment was able to extract N from the profile that otherwise would not have been absorbed by the crop”

# Gypsum to Ameliorate Subsoil Acidity

- Mill Creek Farm, Mahoning County, OH
- Wooster silt loam
- 2 types of gypsum (FGD, mined)
- 4 rates (0, 0.2, 2, 20 Mg/ha)
- Existing pasture (reed canarygrass, orchardgrass, timothy, tall fescue, birdsfoot trefoil)
- Gypsum applied on May 23, 2008.

# Chemistry of Gypsums

	<u>FGD</u>	<u>Mined</u>
pH	7.69	7.95
EC (dS/m)	1.95	5.50
S (%)	18.4	11.0
K ( $\mu\text{g/g}$ )	<75	560
Ca ( $\mu\text{g/g}$ )	87936	104407
Mg ( $\mu\text{g/g}$ )	600	15148

# Chemistry of Gypsums

( $\mu\text{g/g}$  except Hg)

	<u>FGD</u>	<u>Mined</u>
As	<1.284	<1.284
Cd	0.158	0.157
Cr	1.801	3.407
Ni	0.884	2.273
Pb	<0.774	<0.774
Se	<2.321	<2.321
Cu	3.25	<0.378
Hg (ng/g)	376.1	2.7

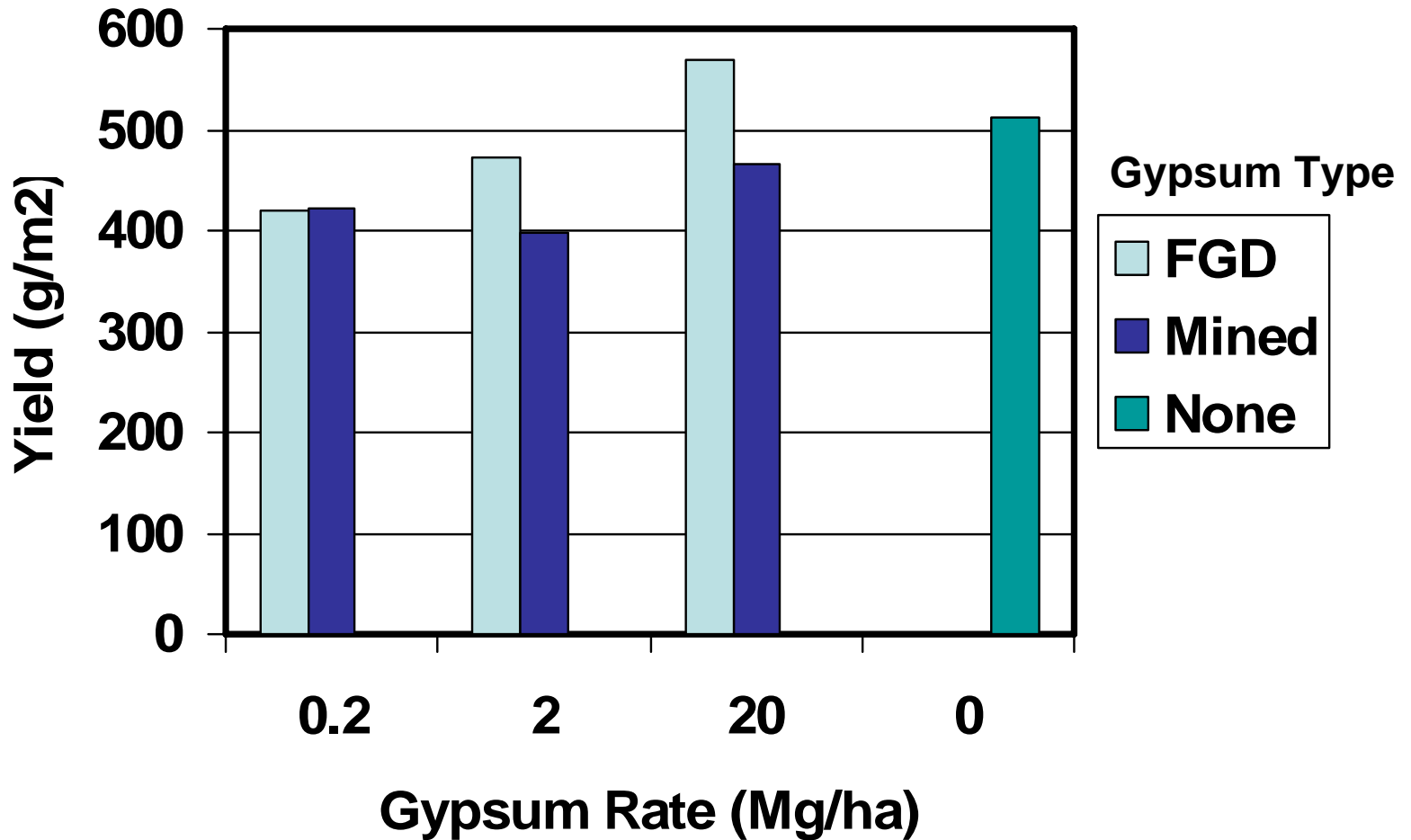
**First yield cutting (July 23, 2008)**



07/23/2008 10:30

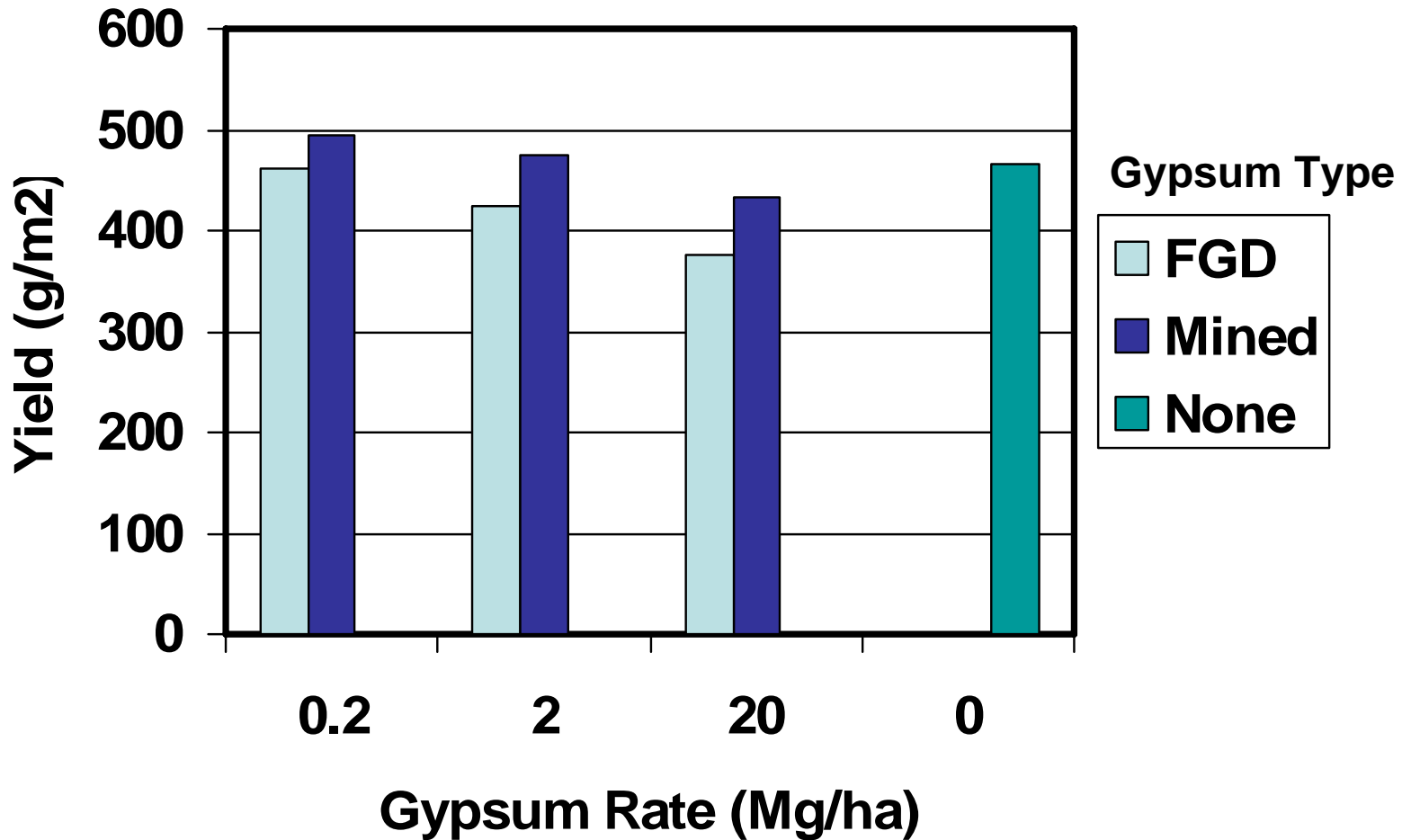
# Pasture Yield - 2008

(total for 2 cuttings in year 1)

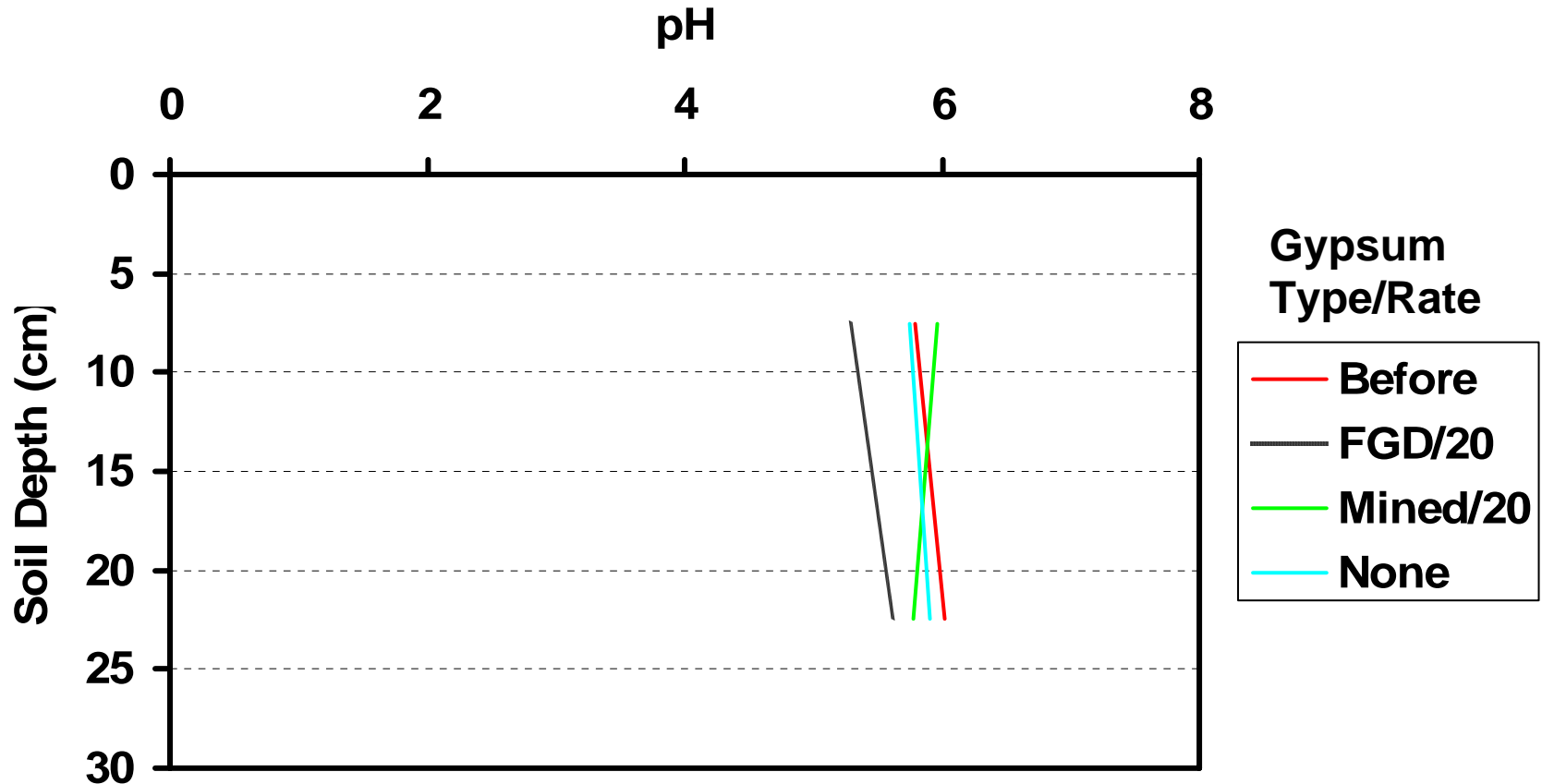


# Pasture Yield - 2009

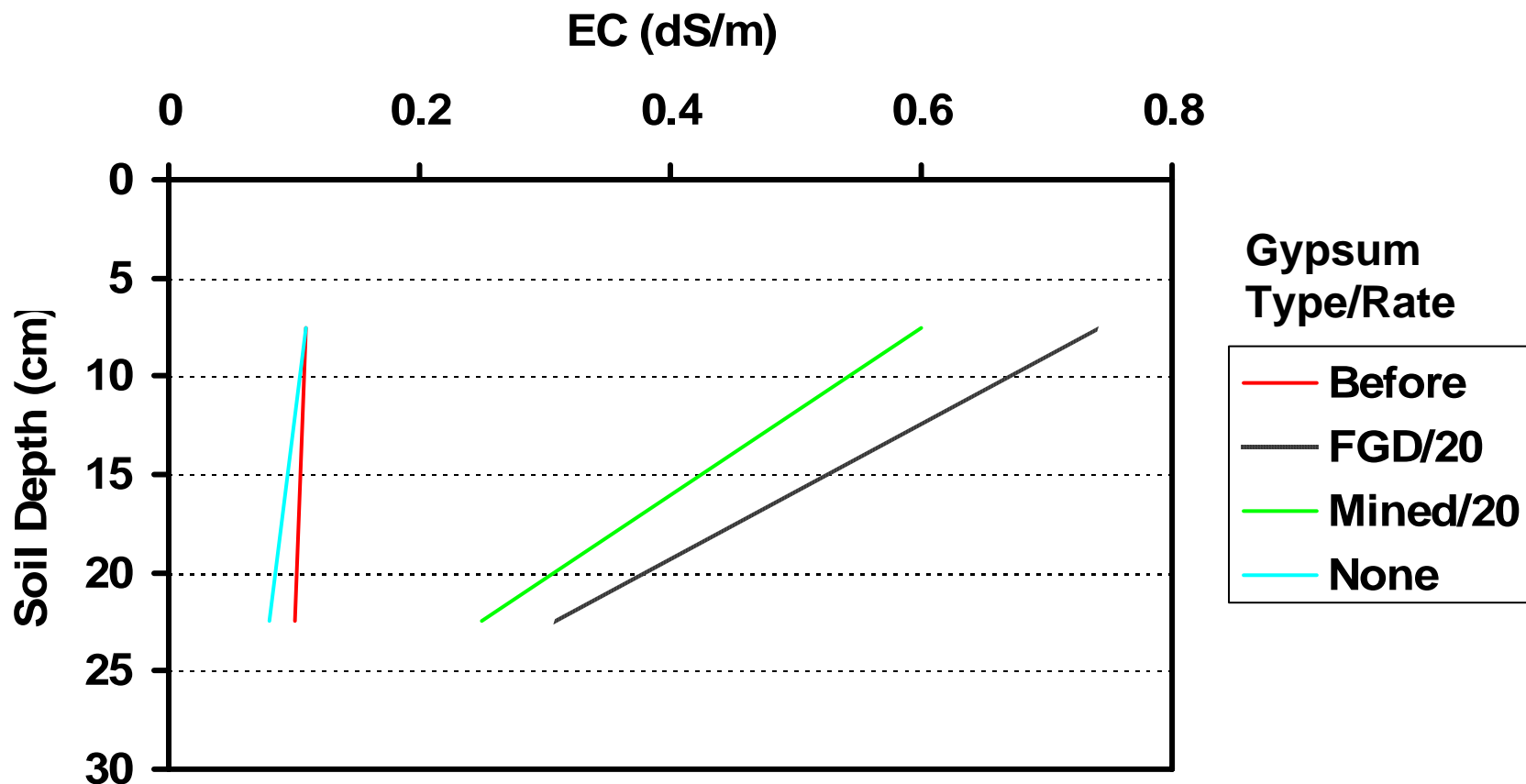
(total for 3 cuttings in year 2)



# Soil pH before treatment and 1 year after gypsum amendments

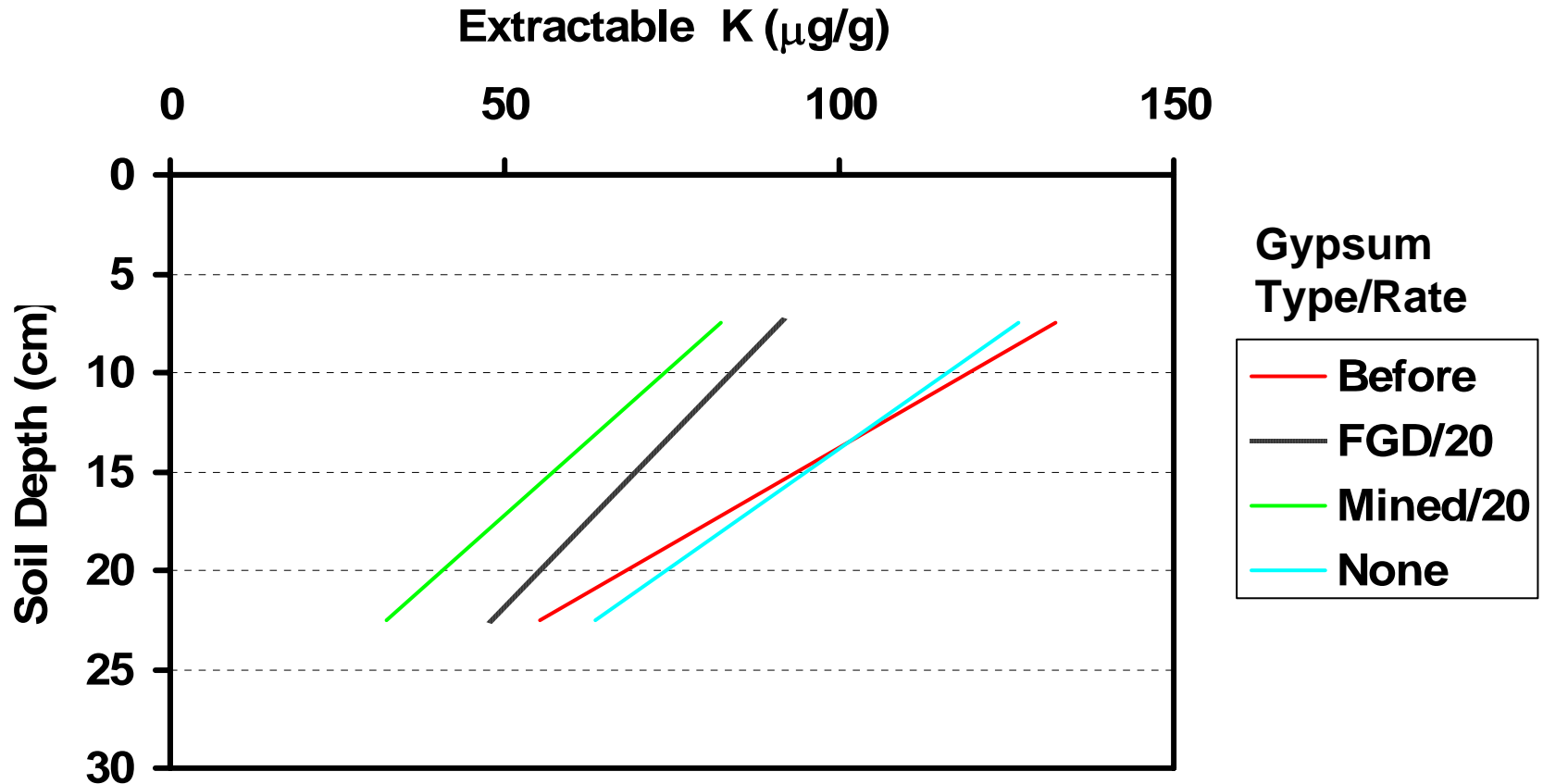


# Soil EC before treatment and 1 year after gypsum amendments



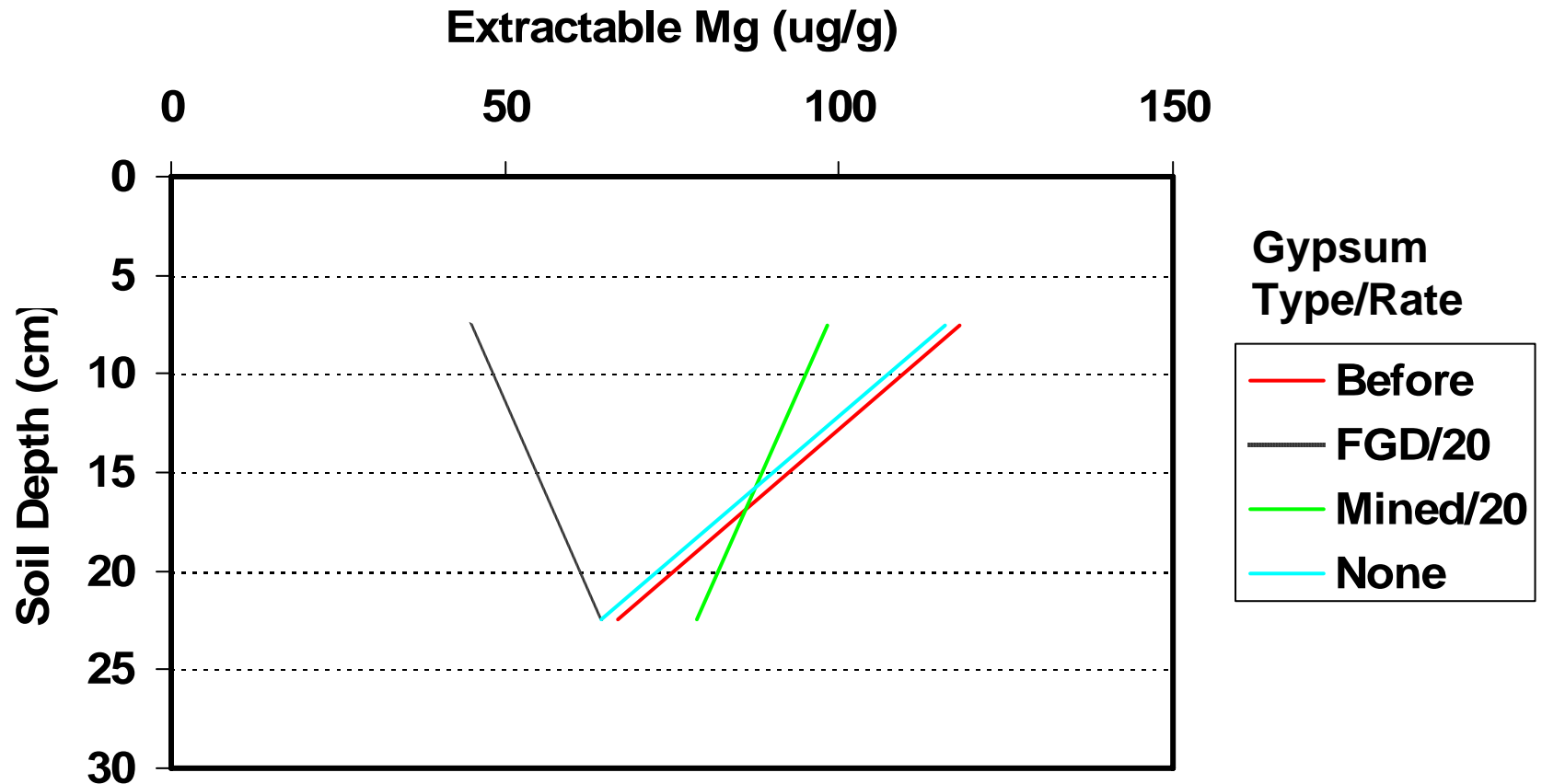
# Extractable K (Mehlich)

## Before and 1 year after treatment



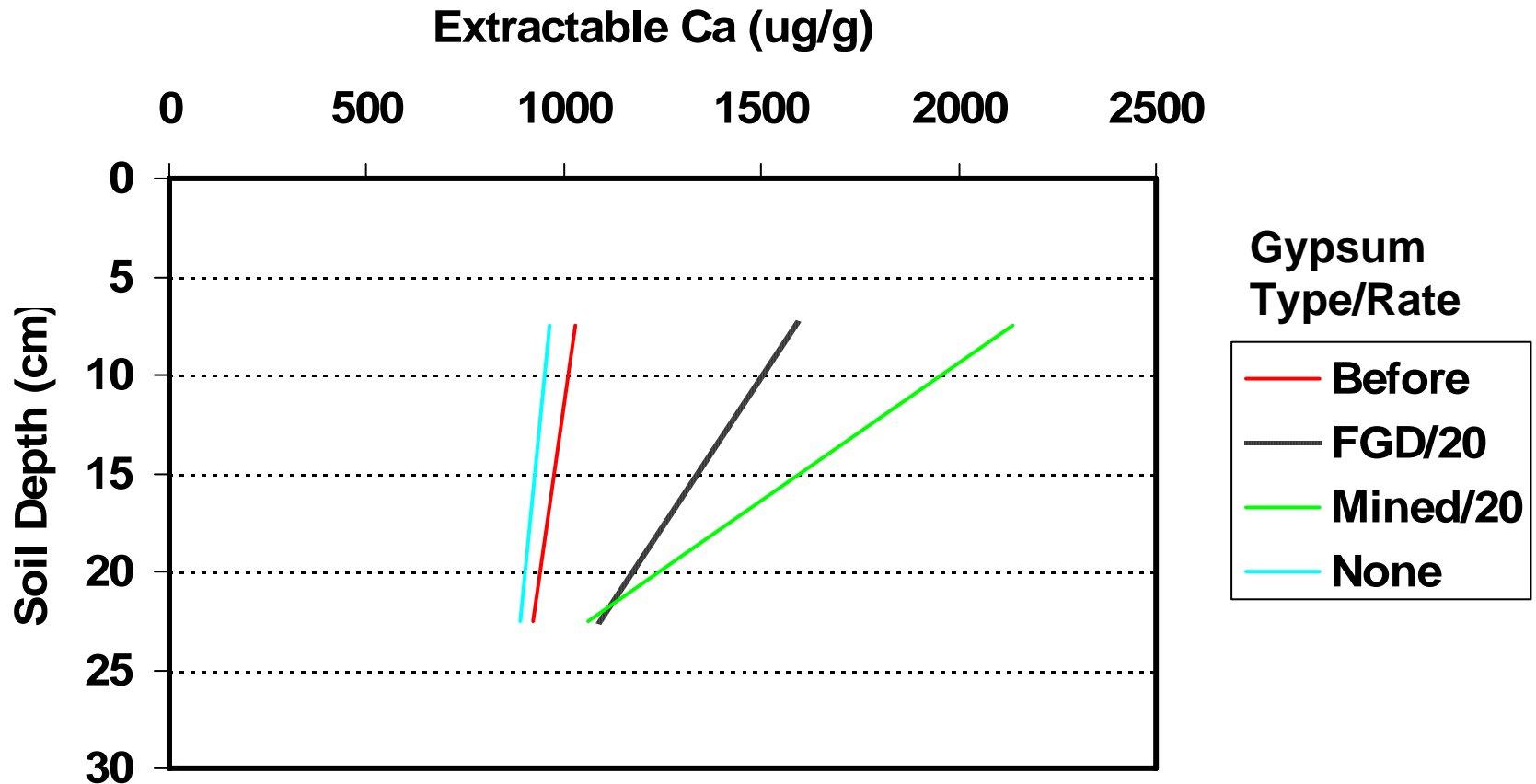
# Extractable Mg (Mehlich)

## Before and 1 year after treatment



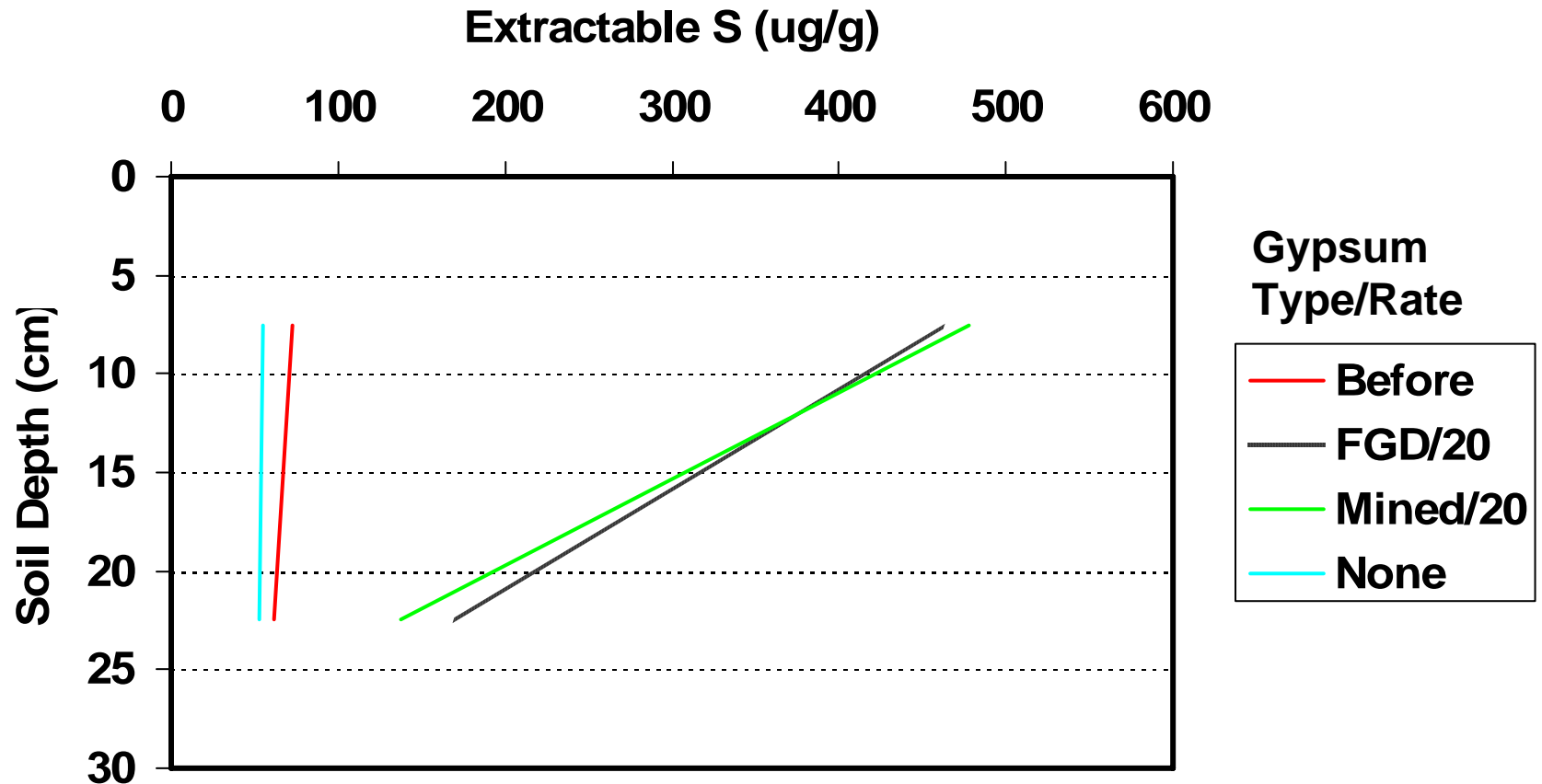
# Extractable Ca (Mehlich)

## Before and 1 year after treatment



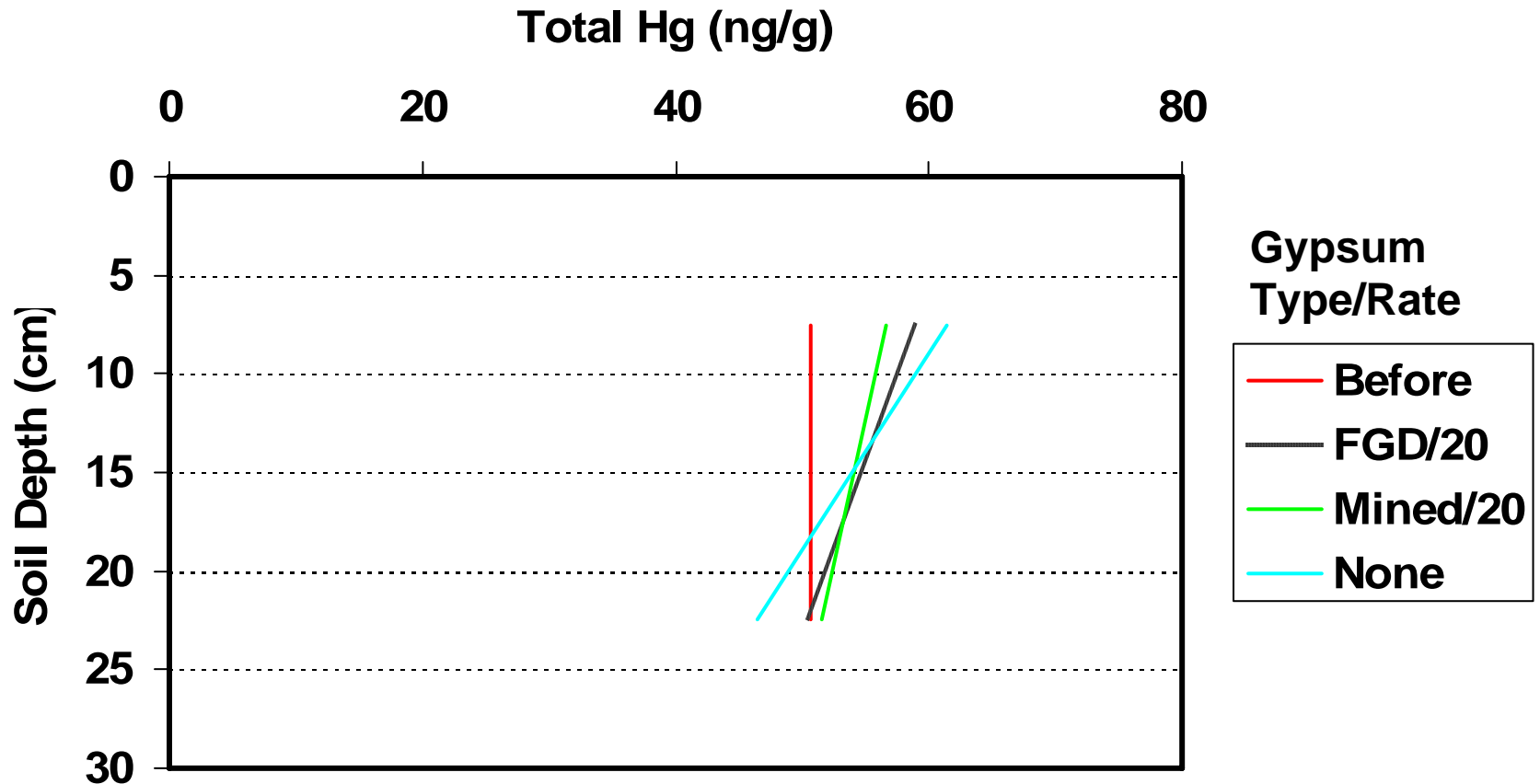
# Extractable S (Mehlich)

## Before and 1 year after treatment



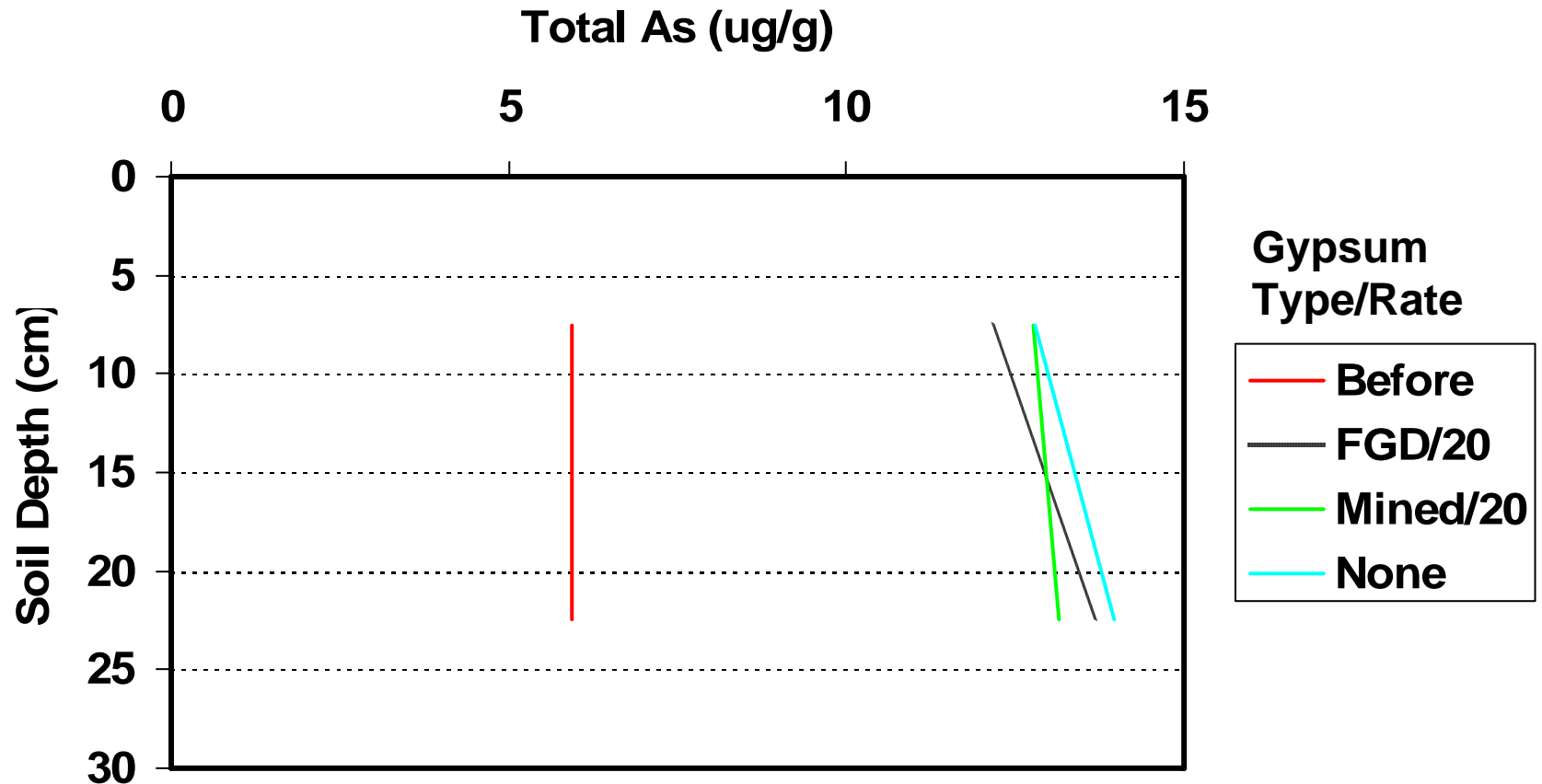
# Total Soil Hg

## Before and 1 year after treatment



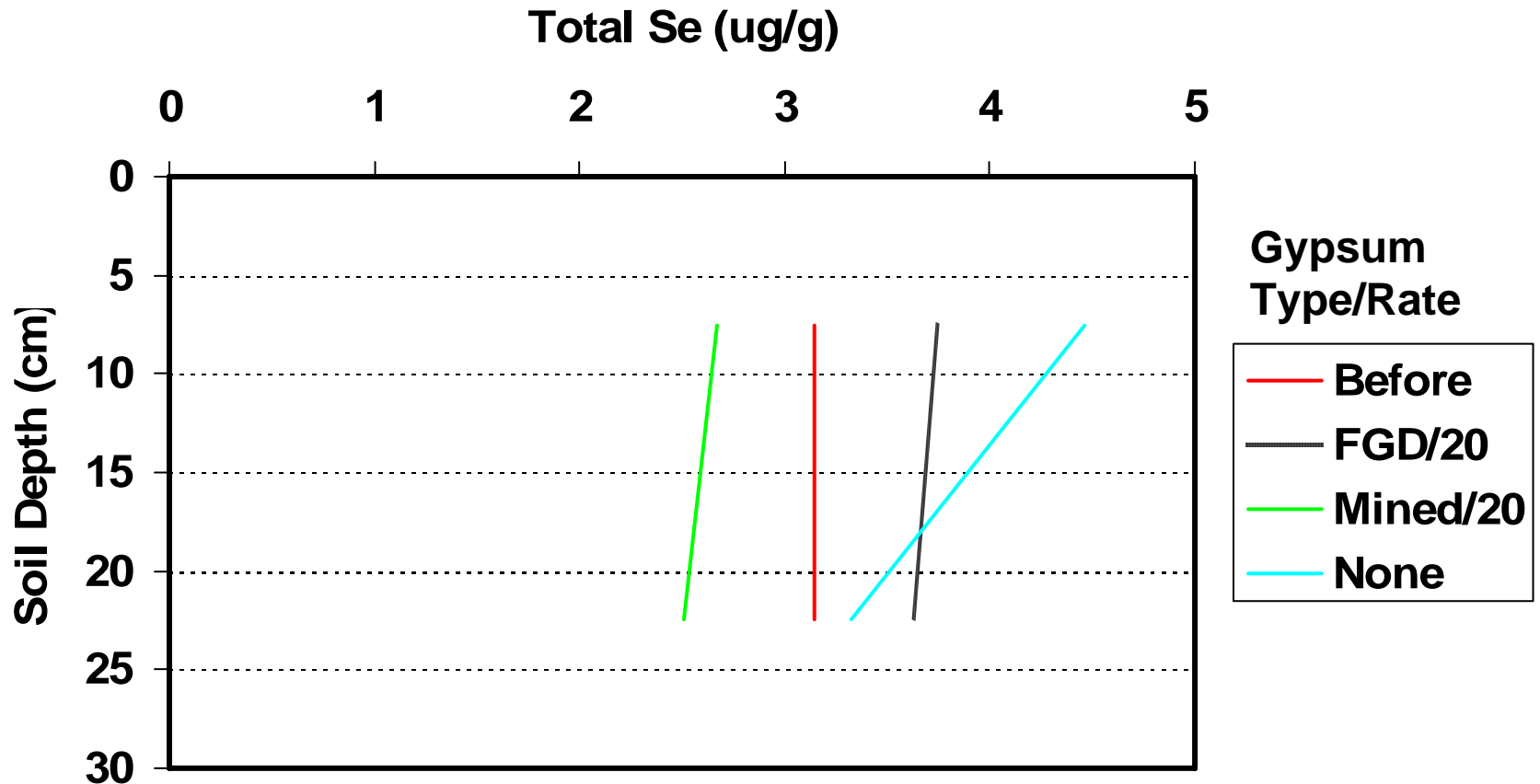
# Total Soil As

## Before and 1 year after treatment



# Total Soil Se

## Before and 1 year after treatment



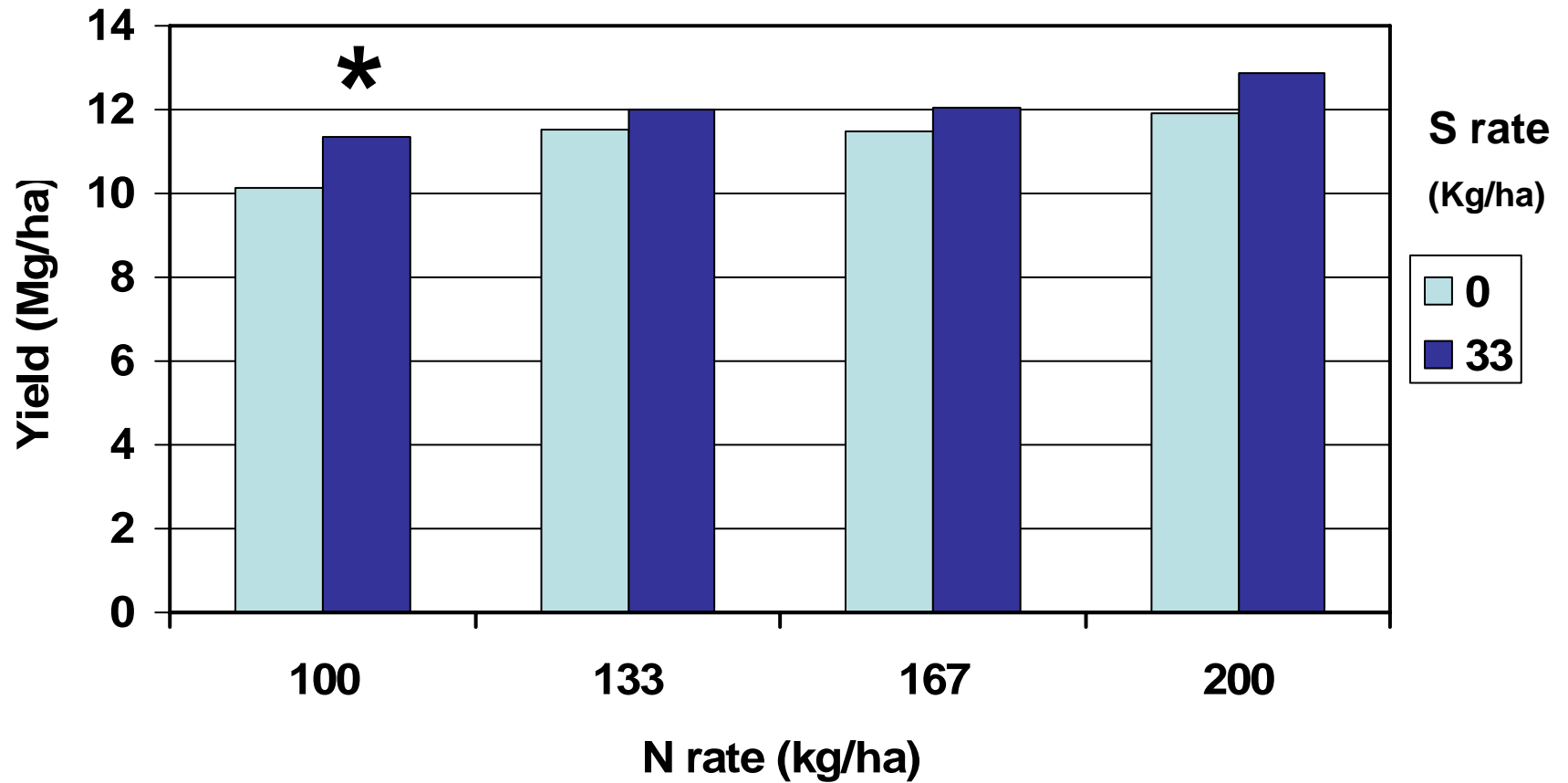
# S Effects on N Utilization Efficiency

- S deficiency reduces N utilization efficiency
- N losses by volatilization and leaching may increase
- Each kg of S shortfall causes 15 kg of N to be lost to the environment

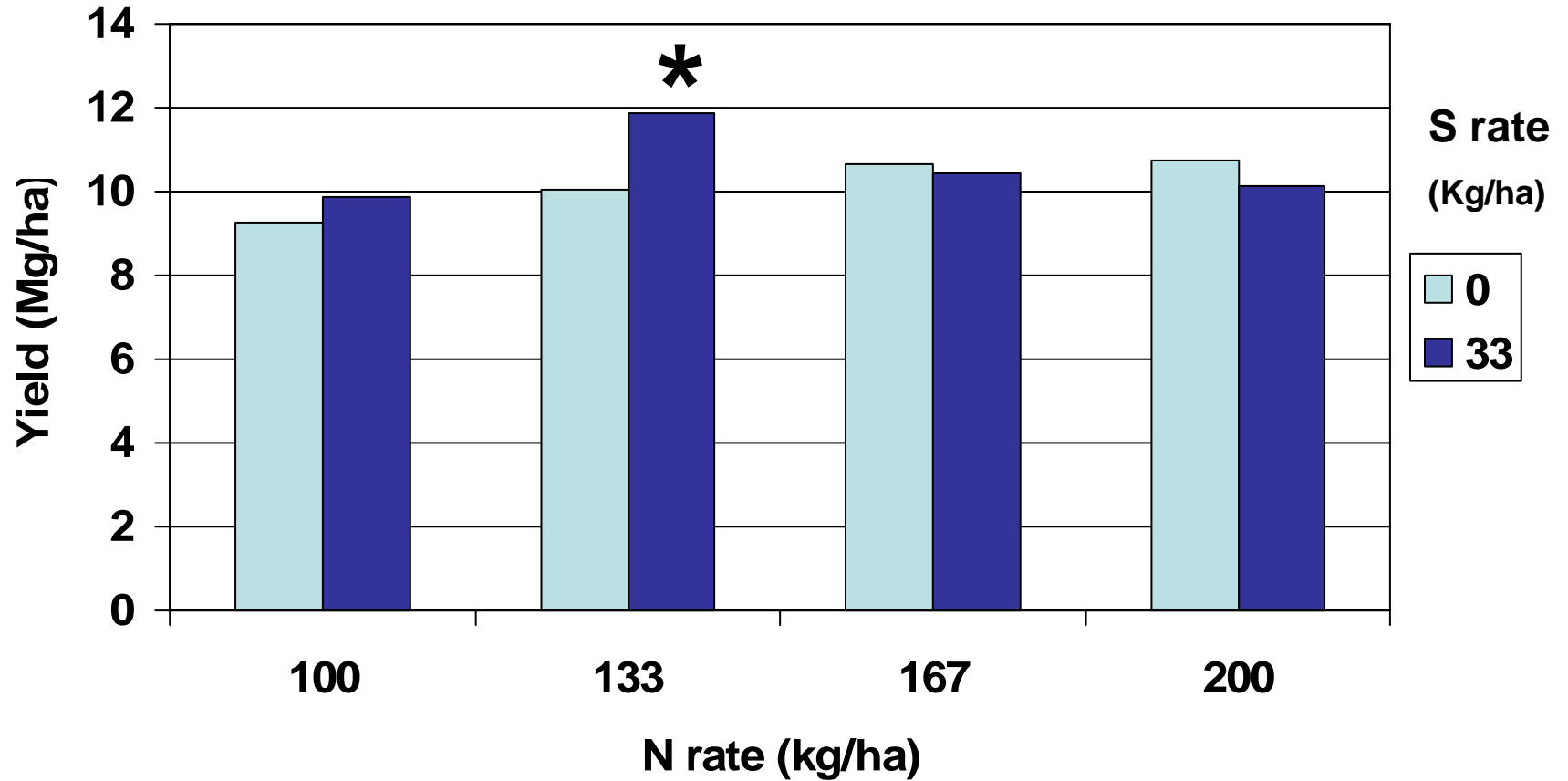
# Interaction of N and S (gypsum) on Corn Yields

- Wooster silt loam
- N rates
  - 0, 67, 100, 133, 167, 200, 233 kg/ha
- S rates (as FGD gypsum)
  - 0, 33 kg/ha
- FGD gypsum had 16.4% S
  - Gypsum rates were 0, 201 kg/ha

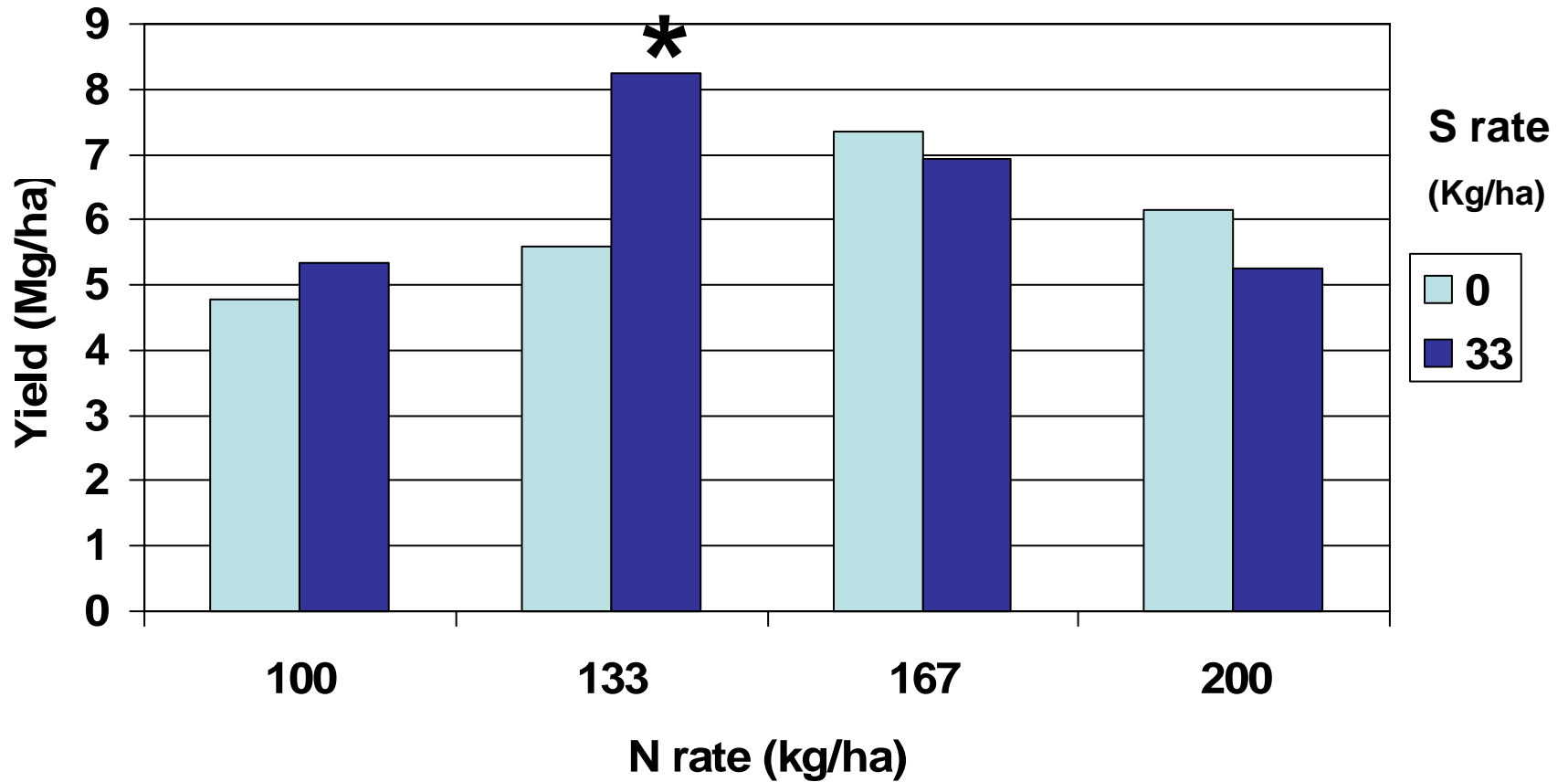
# Corn grain yield in 2003



# Corn grain yield in 2004



# Corn grain yield in 2005



# Summary

- Corn and alfalfa yields in South Africa and Georgia increased strongly by gypsum
- Pasture yield in Ohio not increased significantly with gypsum on acid subsoil
- N recovery by corn crop increased strongly by  $\text{CaSO}_4$  in Brazil
- S as gypsum increased corn yield at some lower N rates (100 and 133 kg N/ha)