

A close-up photograph of a pine branch with vibrant green needles. The needles are densely packed and have a fine, needle-like texture. A semi-transparent dark green rectangular box is centered over the image, containing white text. The text reads: "Foliar sulfate: a diagnostic tool for forest fertilization response???"

Foliar sulfate: a diagnostic tool for forest fertilization response???

Question

Can foliar sulfate be used effectively as a diagnostic tool for identifying sulfur deficiencies?



Why sulfur?

S deficiency may be limiting growth response to N

- Inland Pacific Northwest
- Australia
- British Columbia

IFTNC data show consistent trends in S deficiencies for Douglas-fir

Potlatch Screening Trials 2002-2005

- N always limiting
- S is second most common deficiency

Methods currently used for diagnosis and prediction:

Foliar analysis

- critical levels
- nutrient ratios
- vector analysis

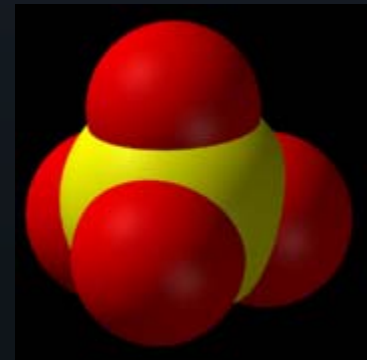
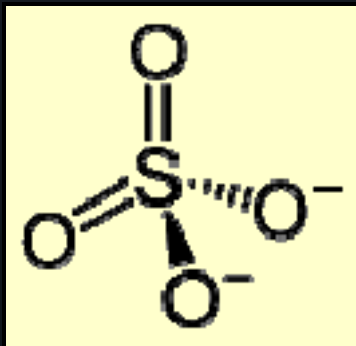
Diagnosis based on response to fertilization

Why sulfate?

A more sensitive indicator of sulfur status?

Physiology:

- N and S needed in specific proportions to build proteins
- Most S in plant tissue is found in proteins
- Excess S stored in leaf tissue as sulfate



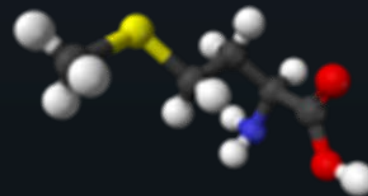
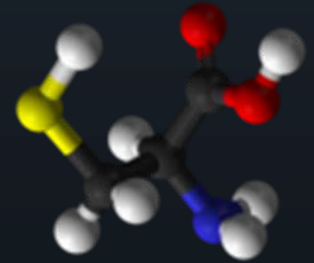
Nitrogen to Sulfur Ratio in Foliage

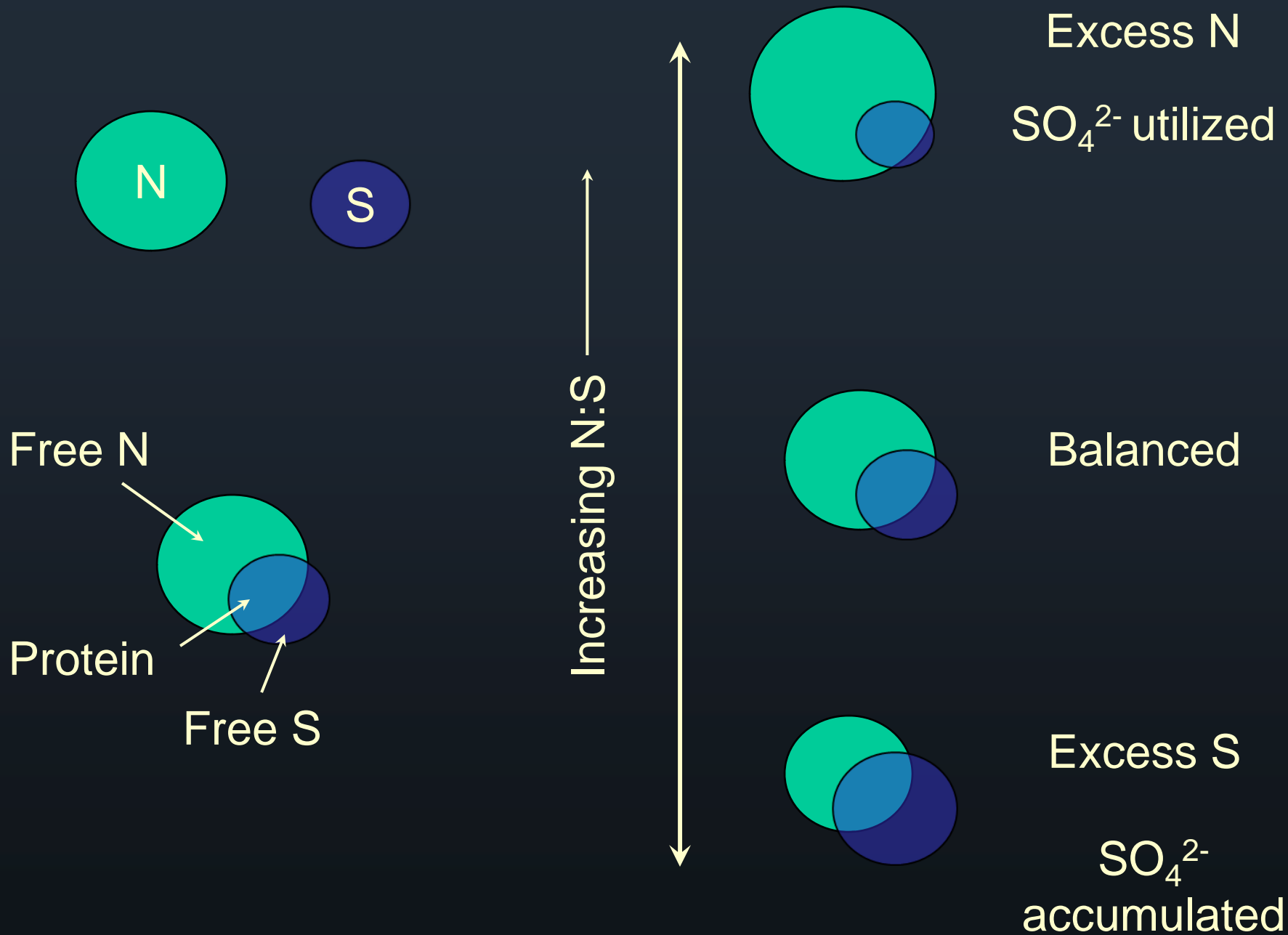
Starting point: Ratio of N to S in *protein*

- Genetically determined, very similar ratio for *all* plants

Surplus N and S are accumulated

- N → free amino acids, NO_3^-
- S → sulfate (SO_4^{2-})





Ratio in protein:

$$\frac{N}{S} = 14.6$$

Increasing

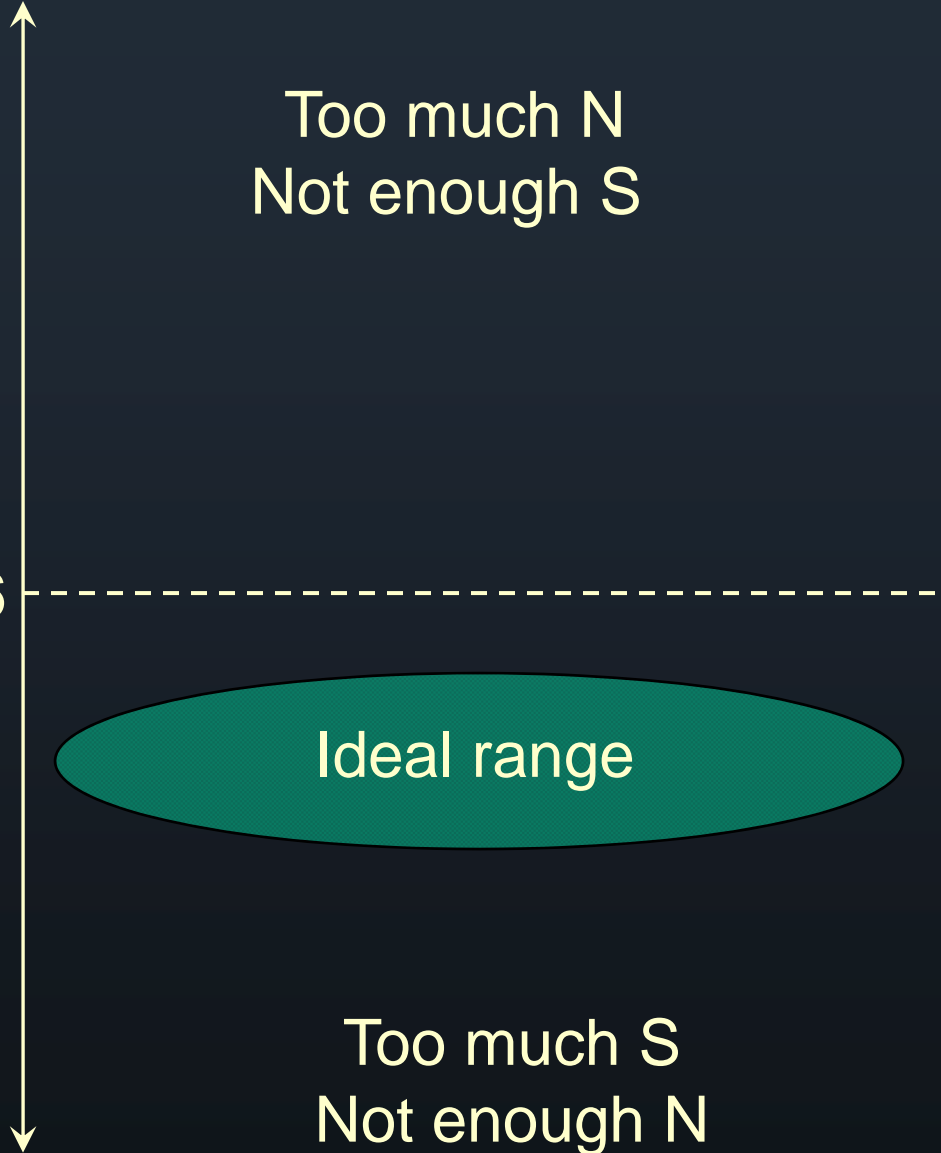
$$\frac{N}{S}$$

14.6

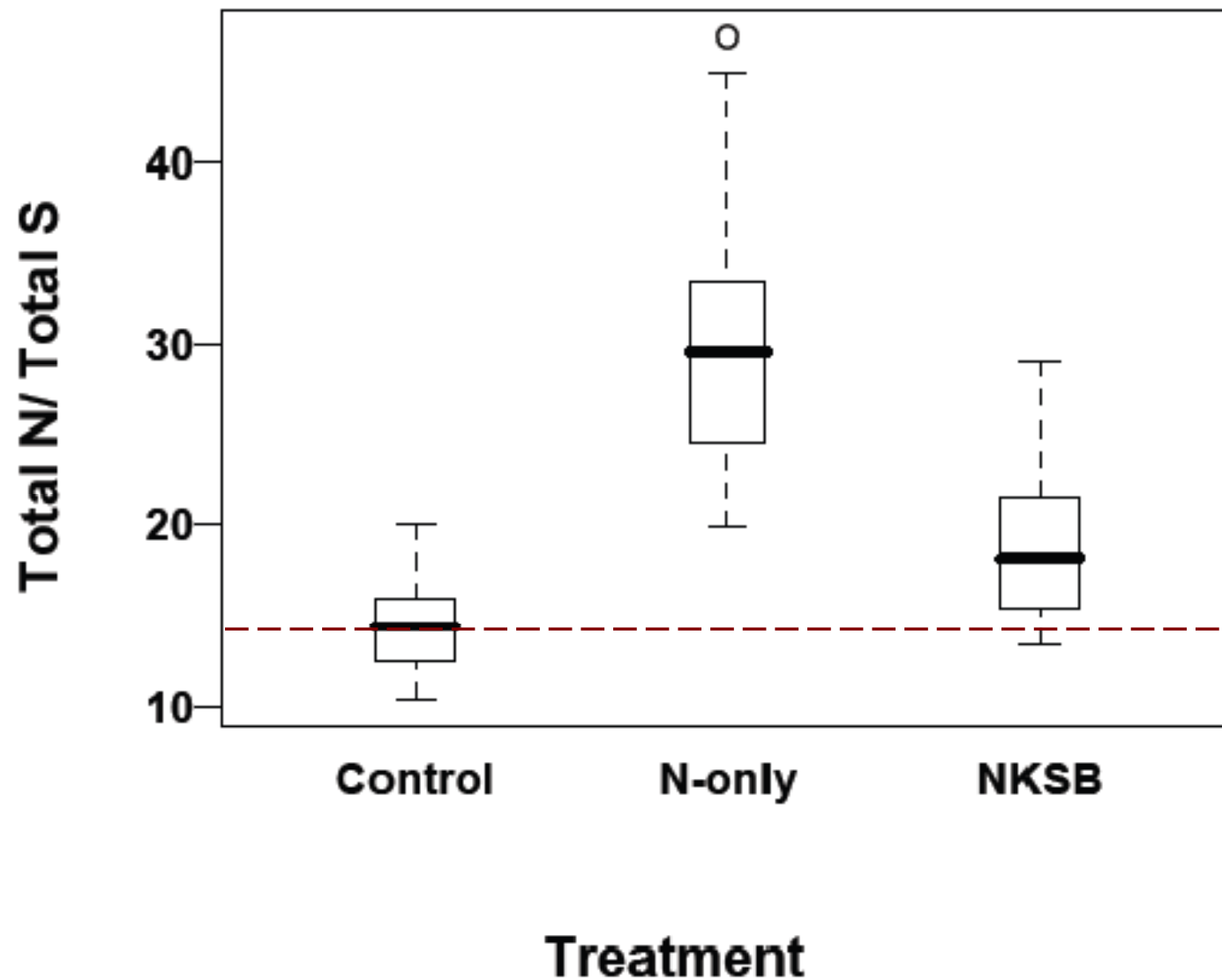
Too much N
Not enough S

Ideal range

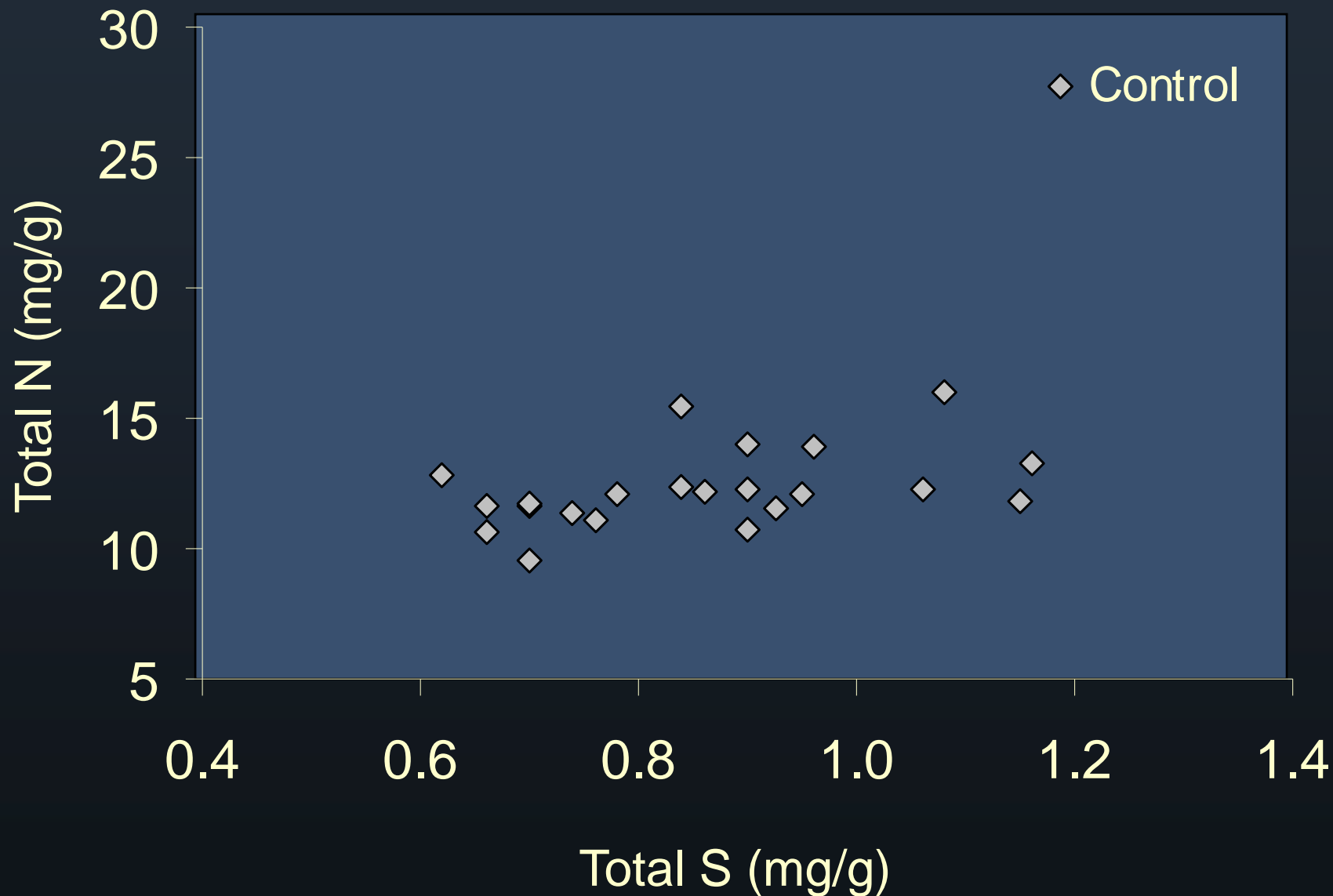
Too much S
Not enough N



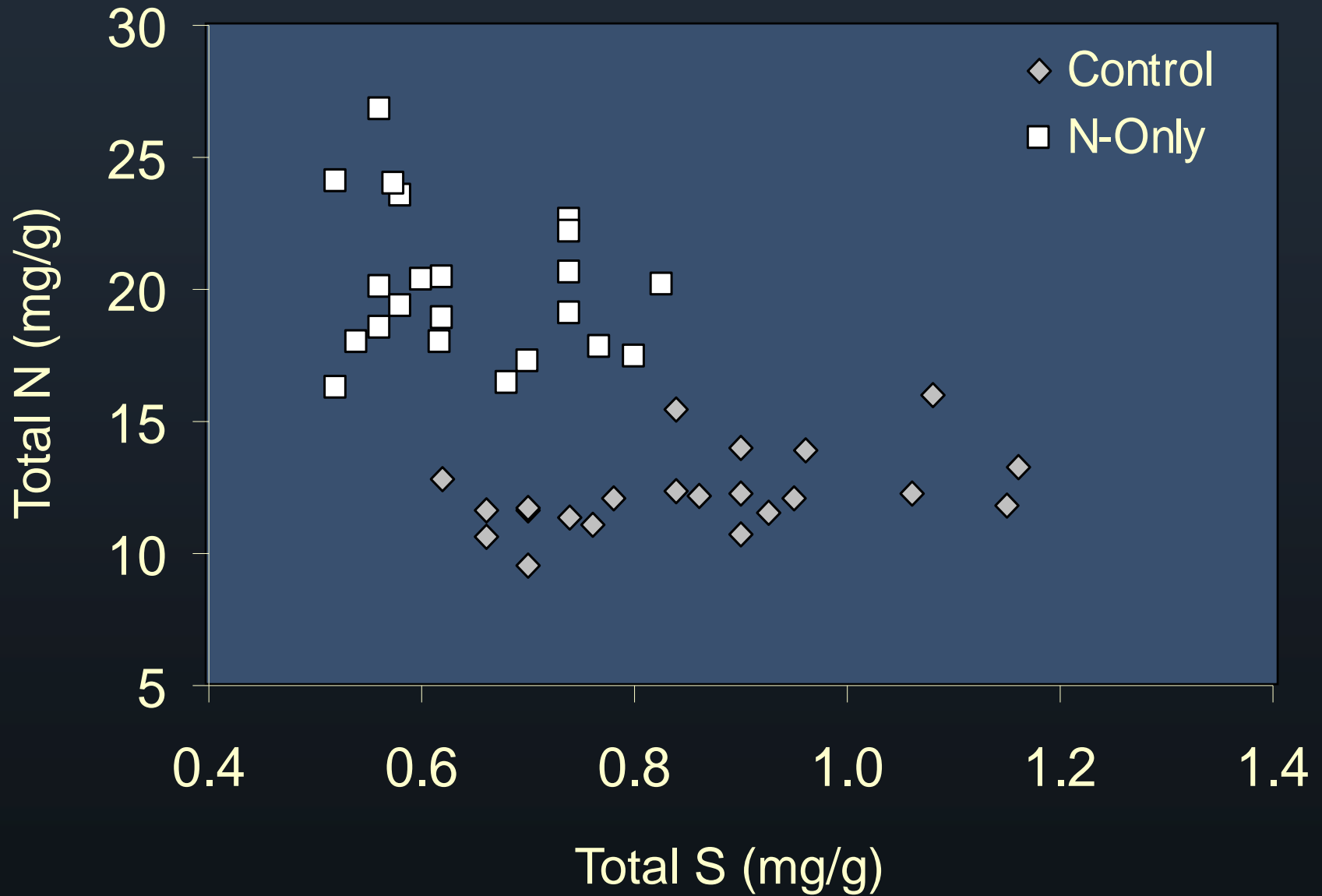
Nitrogen to Sulfur Ratio by Treatment



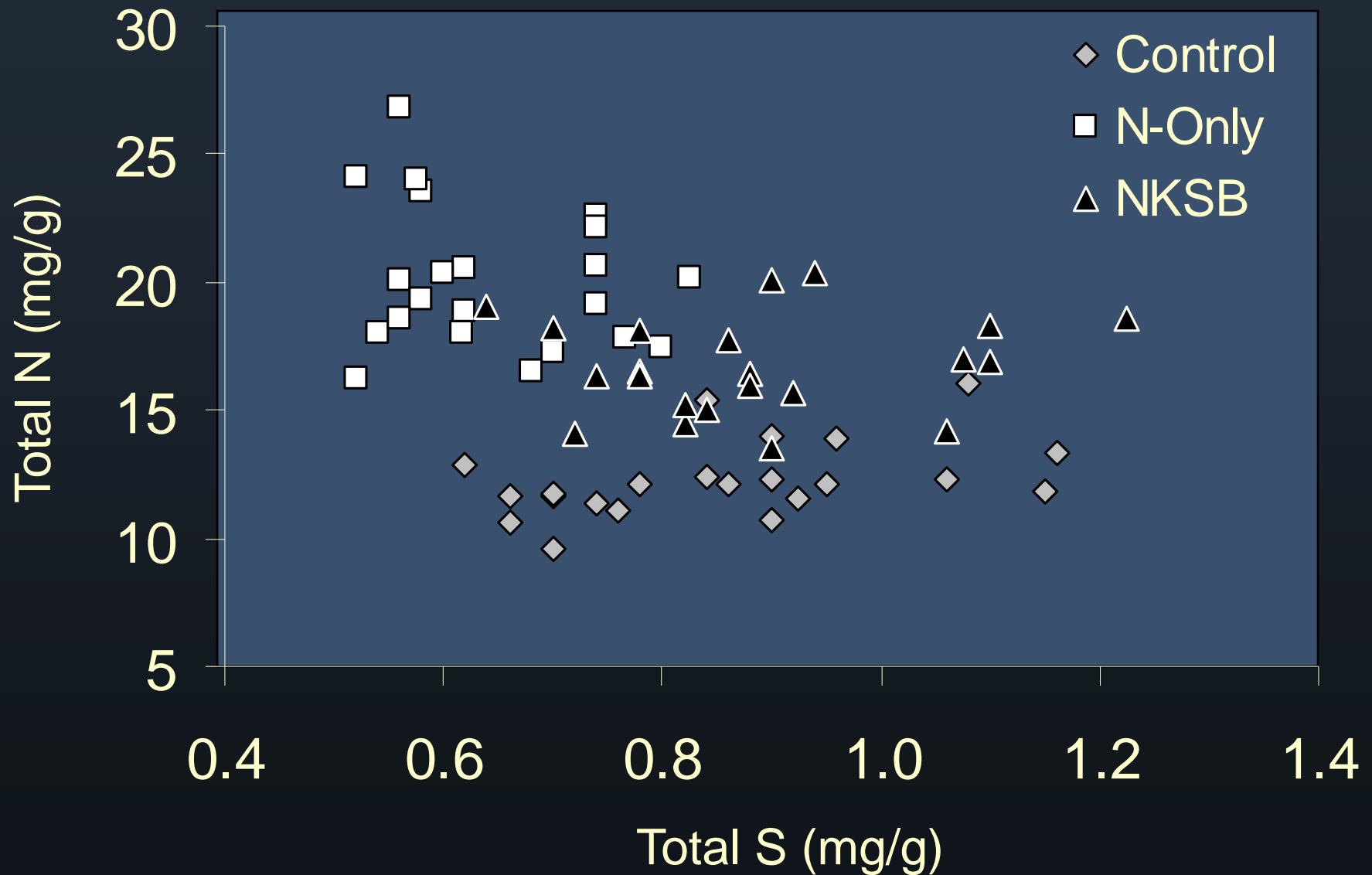
General trend in N and S concentrations



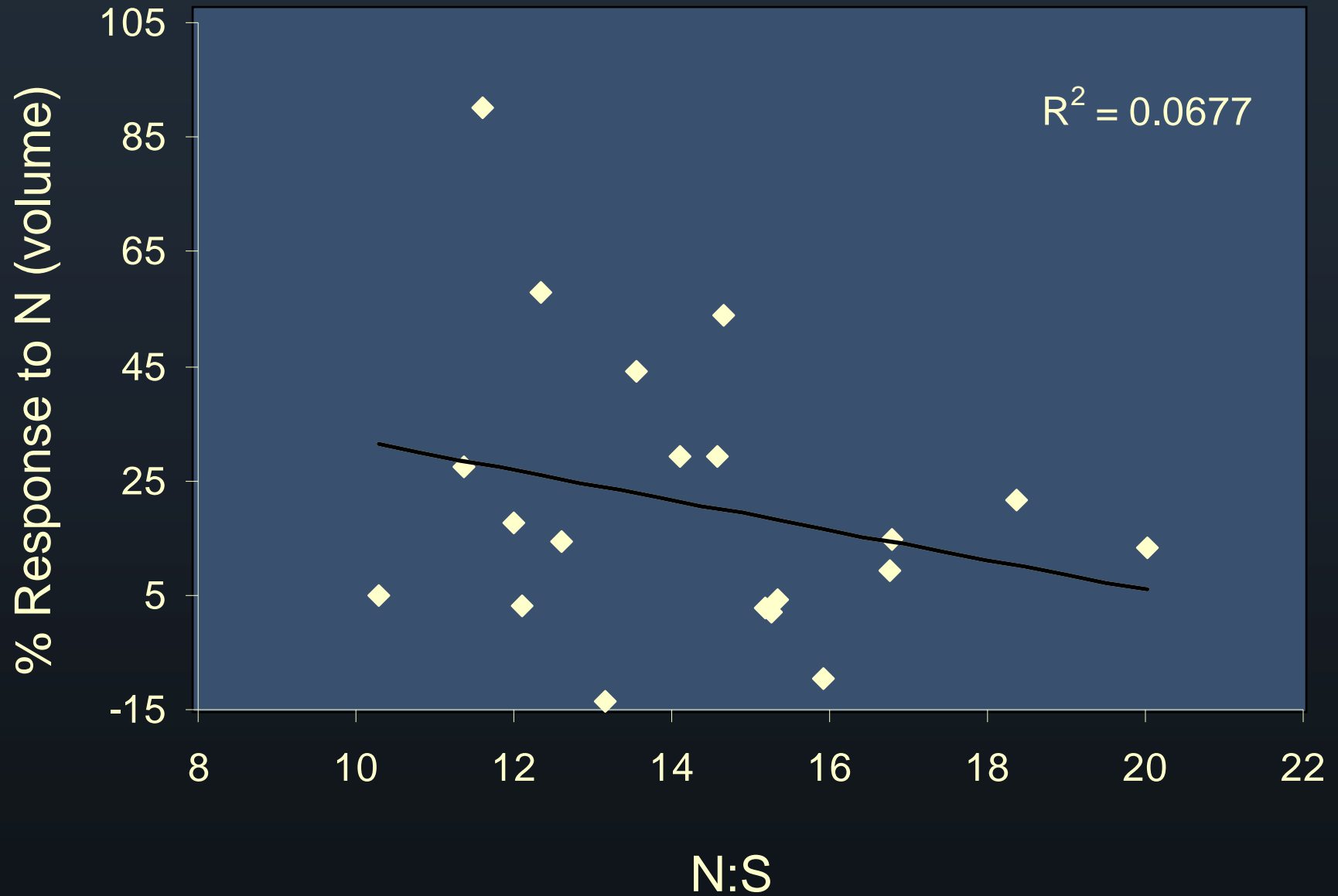
General trend in N and S concentrations



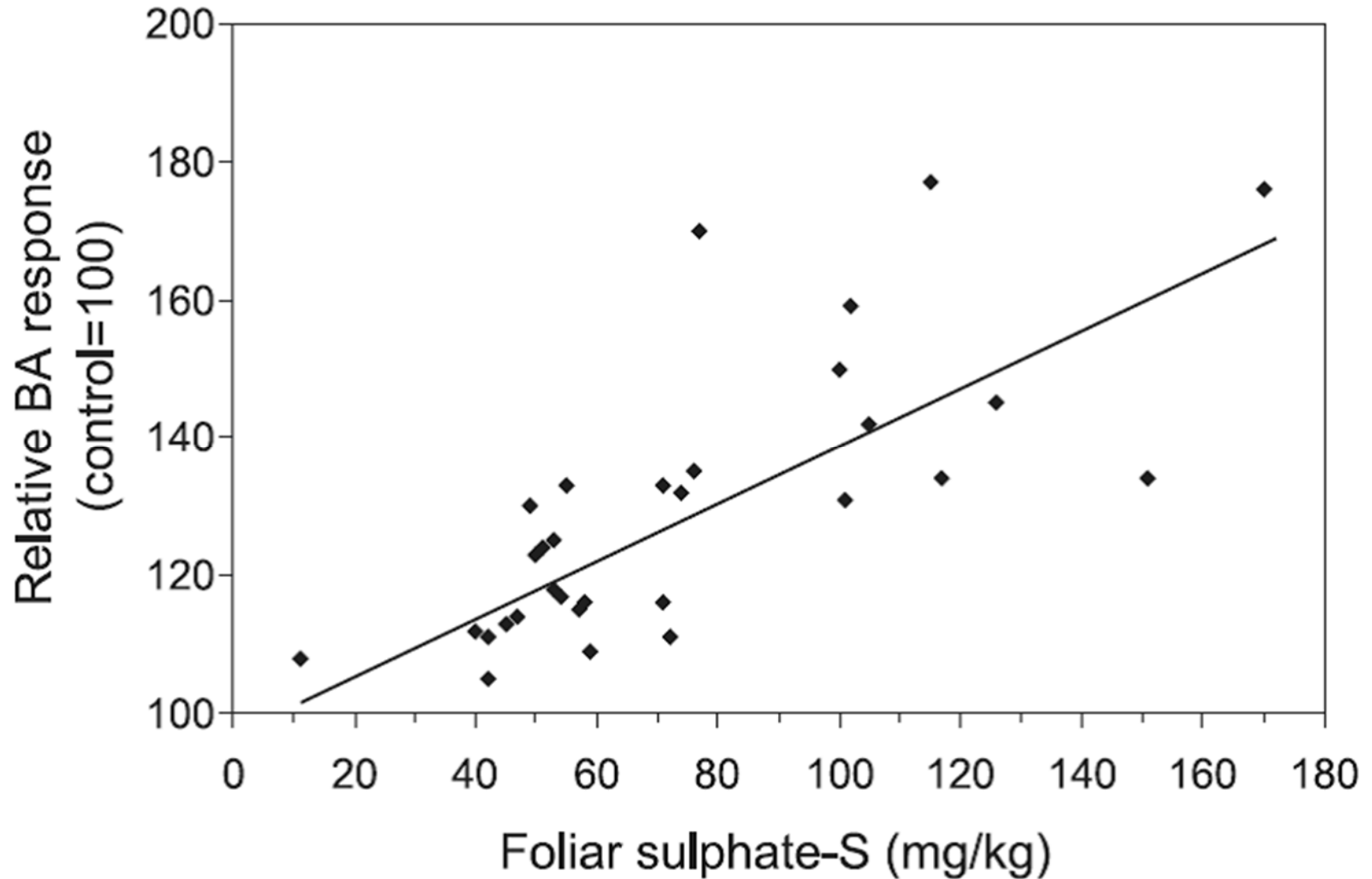
General trend in N and S concentrations



N:S vs. Response



Brockley (2000): Growth response and sulfate levels in lodgepole pine (N-only fertilization)



Our Experiment

Archived samples from screening trials

20 Installations

Three treatments:

Control, N-only, NKSB

Analyzed control samples for sulfate;
related to N-only growth response

Our Research Questions

Are pre-treatment sulfate levels correlated with growth response under N-only fertilization?

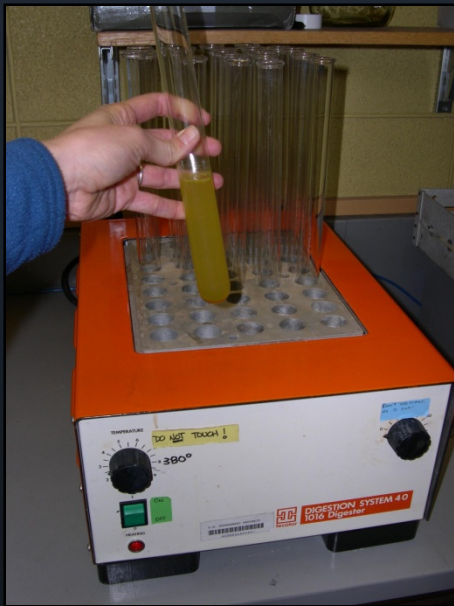
Is foliar sulfate a reliable indicator of growth response to N fertilization?

Methods

Foliage samples dried & ground



Extracted in weak hydrochloric acid



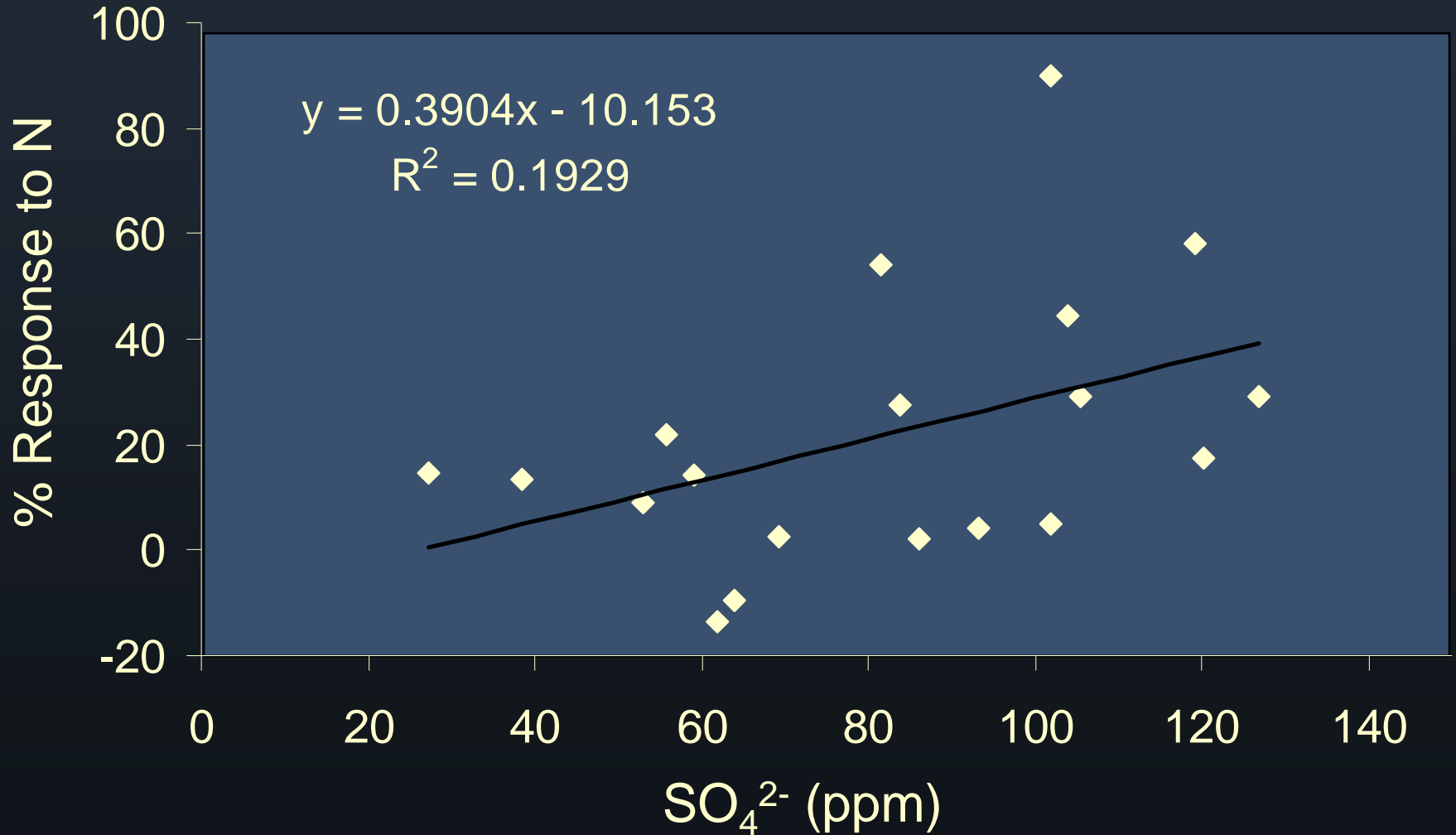
Filtered with 0.45 micron syringe



Analyzed by
ion chromatography

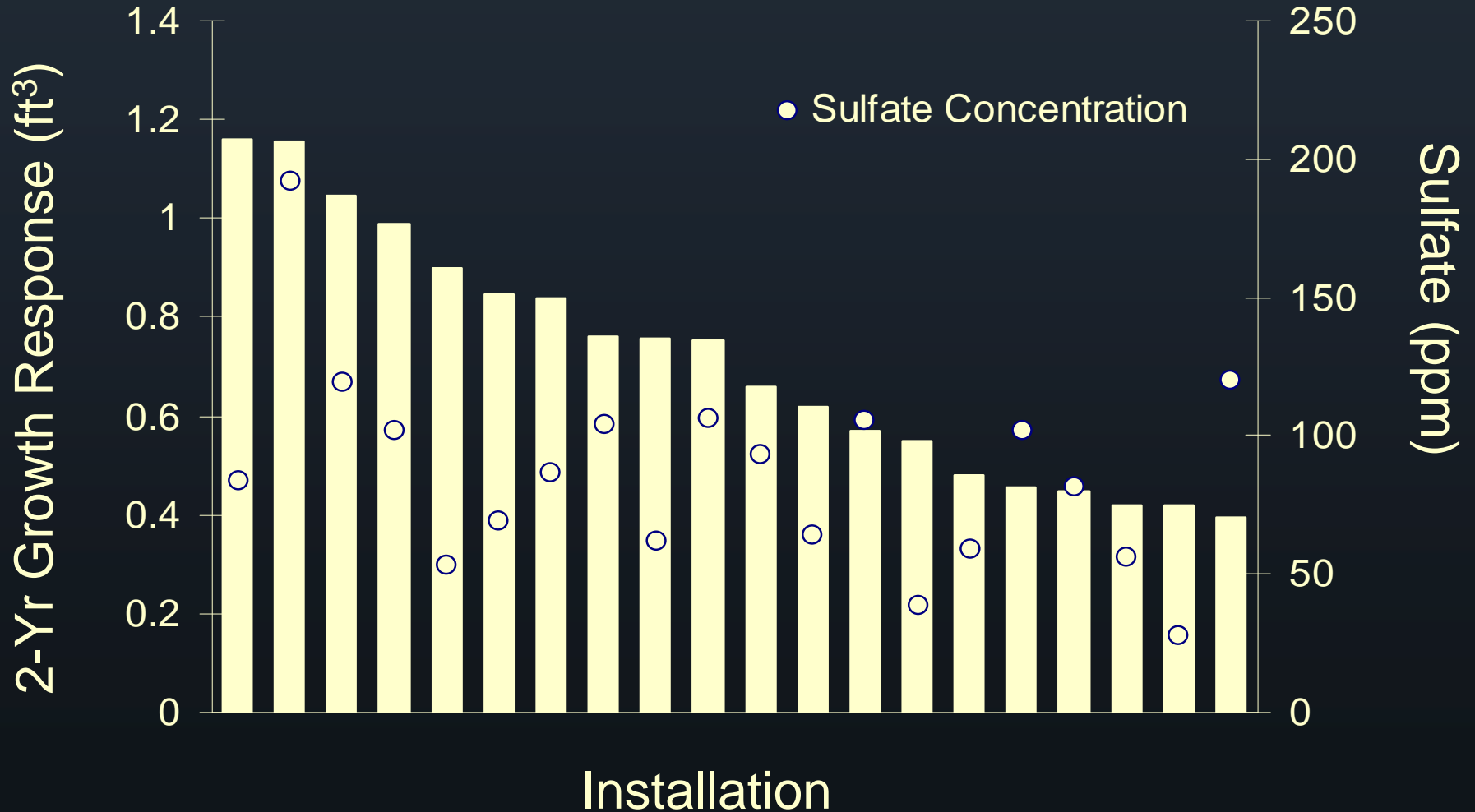
Results

Sulfate vs Response by Installation

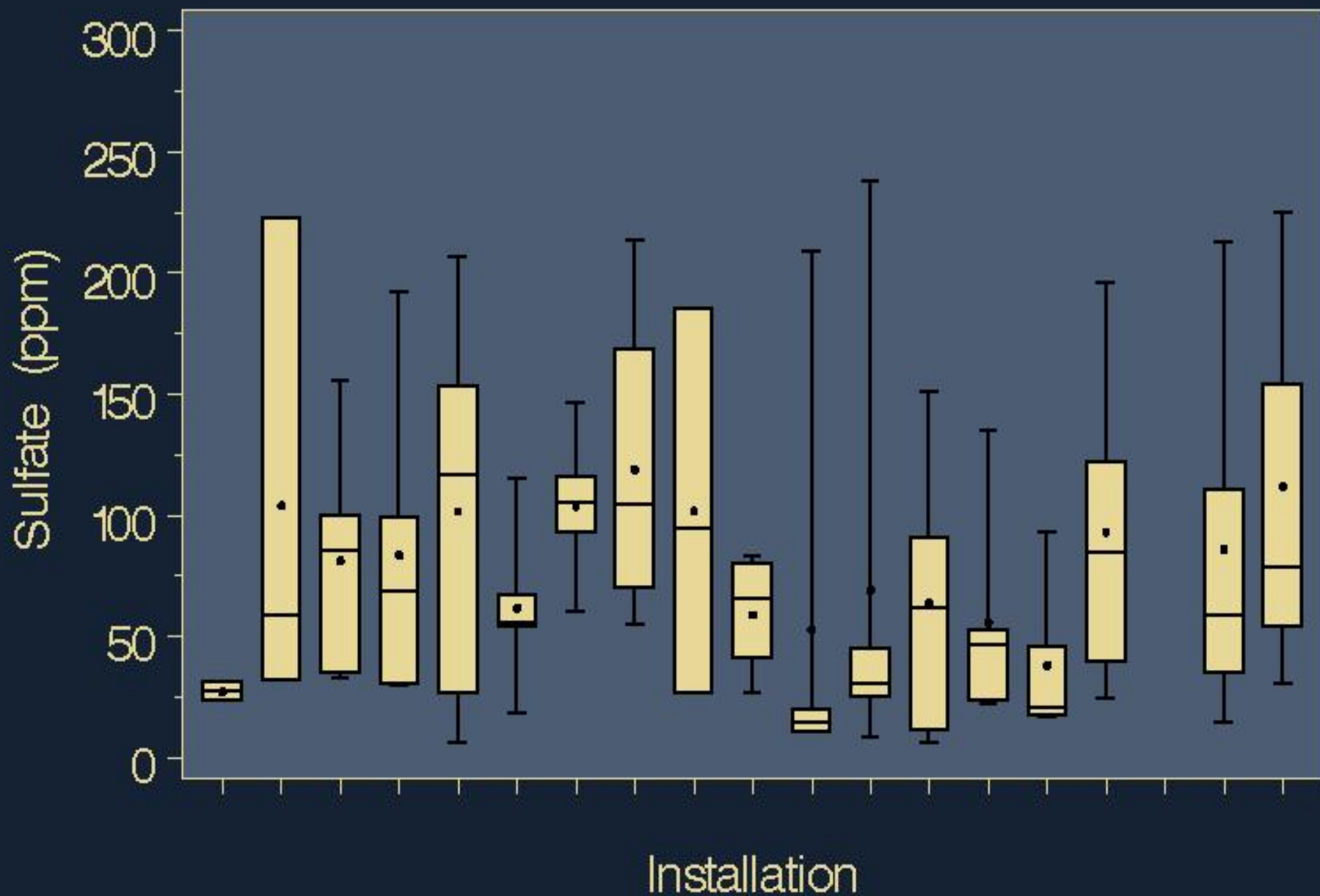


Results

Growth Response vs. Sulfate



Range in Means: SO4



Conclusions

- Correlation between sulfate and growth response to N fertilization is positive, but weak.
- Foliar sulfate *on its own* is probably not a reliable predictor of nutrient deficiencies or growth response.
- Foliar sulfate may still be useful in combination with other measures to predict stand nutrient characteristics.