Nutrient Losses during Temporary Field Storage of Poultry Manure

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THE ISSUES

- Temporary field storage is common in the Delmarva Region
- Is there evidence to suggest that after 14 days litter should be covered if stored in the field?
- Local growers suggest covering with poly is not very practical
- Current Delaware policy allows uncovered piles for up to 150 days if certain procedures are followed

Delaware Policy

- Six-feet tall in conical shape (90 days) and if ten-feet tall up to 150 days (conical shape)
- 100 ft from surface water; 200 ft from well
- When removing litter also remove top 1 to 2 inches of soil and spread it with manure
- Establish on well-drained soil
- Establish crop as soon as practical

Current Level of Knowledge

- No information on nutrient losses from “production-size” litter piles
- All previous information on nutrient losses is from small “research-size” piles
- Some previous studies have used poly under the research pile to collect runoff
- The DNMC et al. decided that information was needed on production-size litter piles

Objectives of this Work

- Determine the quantity and types of nutrients being lost from production-size piles
- Evaluate the impact of storage length (i.e., number of days) on nutrient losses
- Evaluate “alternative” methods of storage (i.e., something other than “nothing” or using a poly cover)

Methodology of Studies

- Large field-size piles
- Piles put out in fall (2005 and 2006) and removed in spring (2006 and 2007)
- Pile 1: Six "time-of-removal" treatments
  - 15, 30, 45, 90, 135, and 180 days
  - Seventh treatment: collected "runoff" from the pile for about 180 days
  - REPLICATED OVER TWO YEARS at two different locations


MACK

Methodology of Studies (Year 1)

Pile 2: Seven "ALTERNATIVE" treatments

- NO COVER
- POLY COVER
- Bentonite Clay as a BASE under the pile
- Spray-on carbon material at TWO rates (material used as a bedding material in North Carolina)
- Sawdust as a BASE under the pile
- Poultry Guard (ammonia control product; granulated sulfuric acid)

Methodology of Studies (Year 2)

- Pile 2: “ALTERNATIVE” treatments
  - NO COVER
  - POLY COVER
  - Soil Tac (spray-on polymer material) that was tested as a COVER and also as a BASE under pile
  - Illinois Silage Biodegradable Spray-On material tested as a cover

Methodology of Studies

- Runoff was collected whenever it occurred and we collected the total volume and subsampled it for nutrient concentration
- Soil samples were taken immediately after the litter was removed and then twice more about 1 and 2 months after removal
- Soil samples were taken from the following depths: 0-6”, 6-12”, 12-24”, 24-36”, and 36-48” (36-48” only in second year of study)

Soil Sampling and Analyses

- YEAR 1: Soil samples were taken outside the pile, on the edge of the pile, and under the pile the first year.
- YEAR 2: Samples were taken outside the pile (20 ft), 2 ft outside, on the edge, 2 ft inside the pile, and under the center of the pile
- Soil was analyzed for ammonium-N, nitrate-N, soluble salts, total-N, and routine soil test (pH, P, K, Ca, Mg, S, Fe, Mn, Cu, and Zn). Below 12” depth was ONLY ammonium and nitrate.

RESULTS

COVERS


Applied on November 11


February 2, 2006


March 20, 2006

Soil Tac as a Spray-On Cover

Soil Tac as a Spray-On Cover

OBSERVATIONS


November 17, 2005


Three events: 0.94”
11/17/05 (0.8”)
November 17, 2005

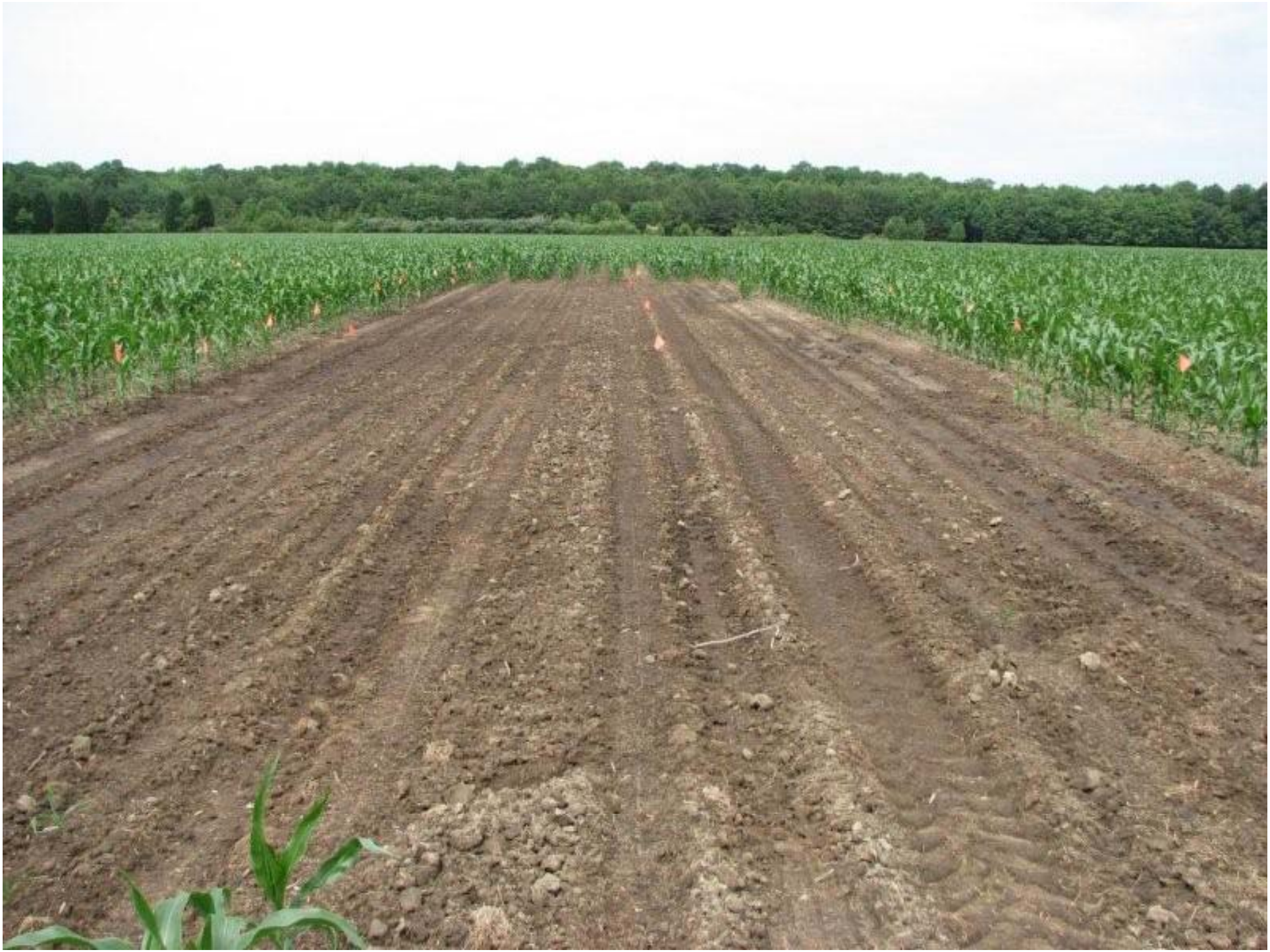

Three events: 0.94”
11/17/05 (0.8”)
November 17, 2005


0.8” on 11/29/05
December 2, 2005

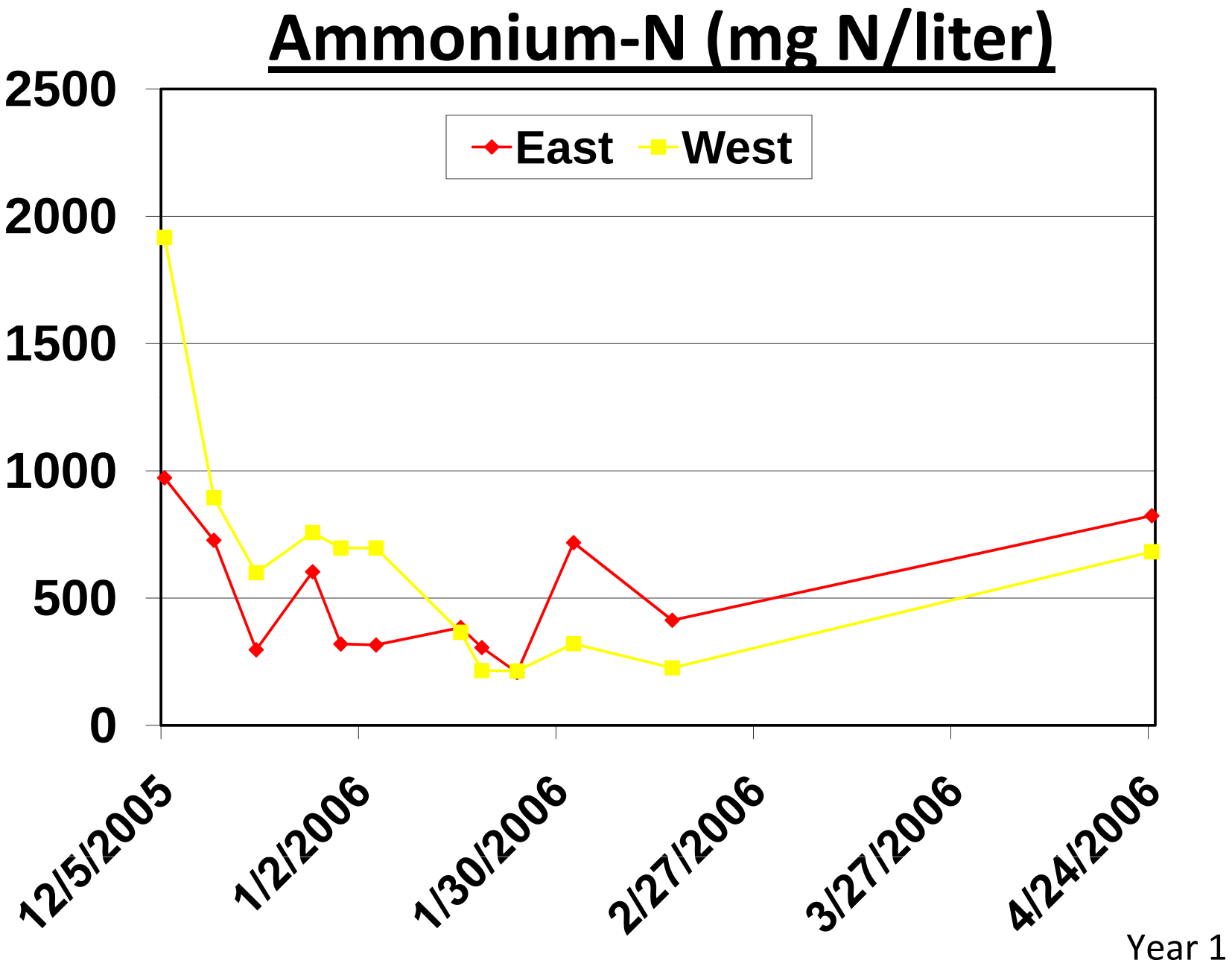

Total rain: 3.12”
December 14, 2005


February 2, 2006

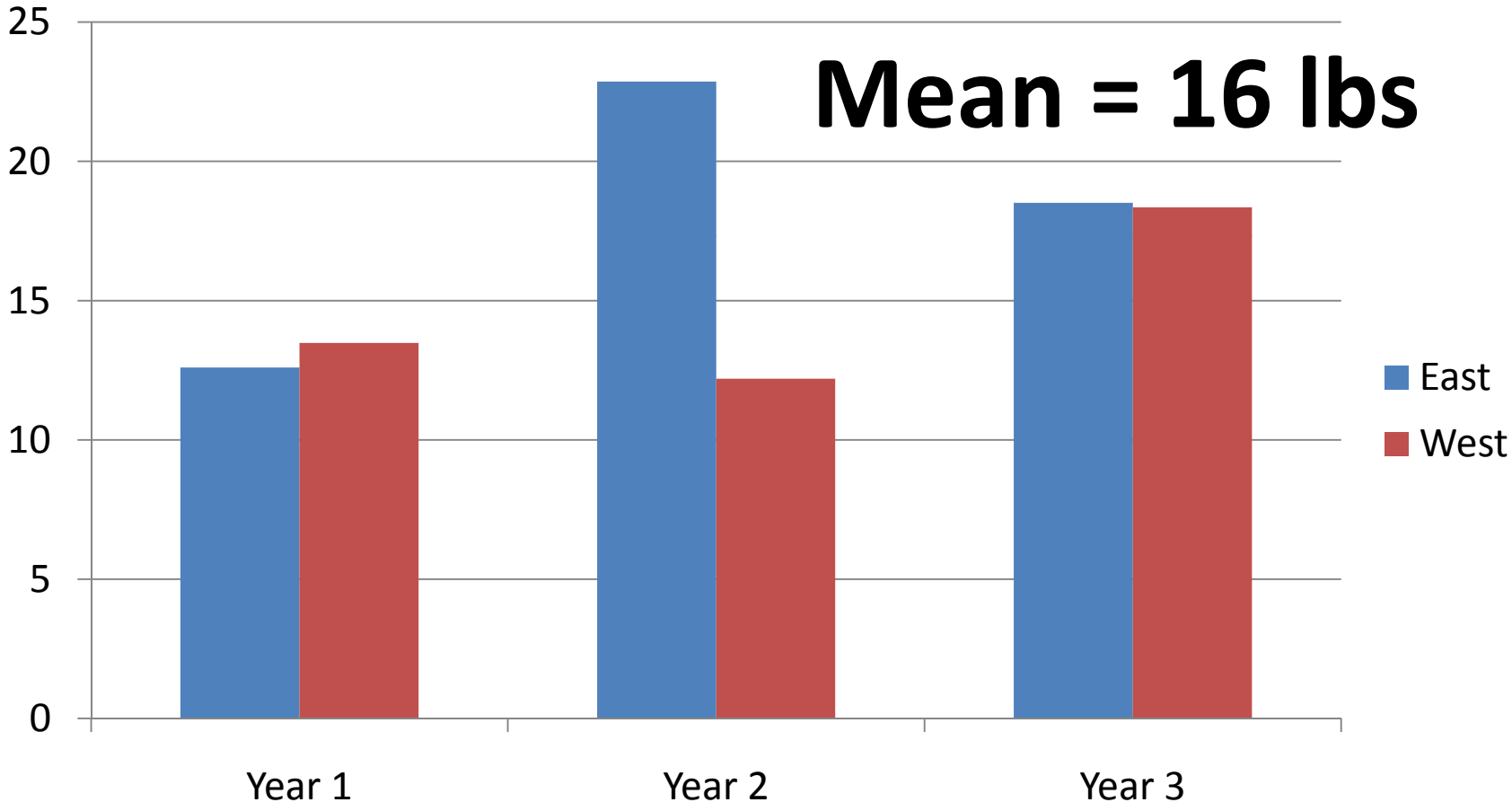

Total rain: 9.8”
March 20, 2006

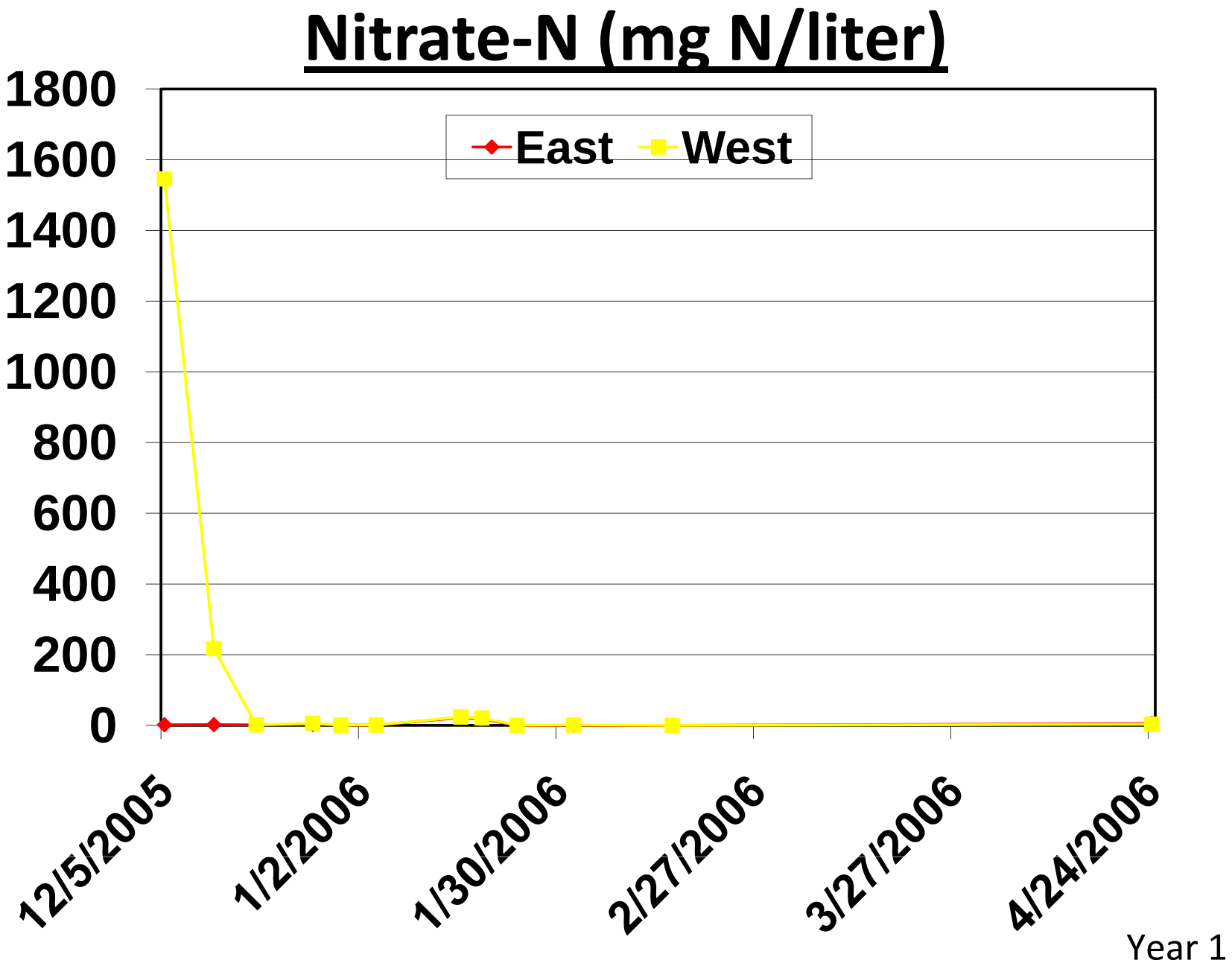


DATA
Runoff

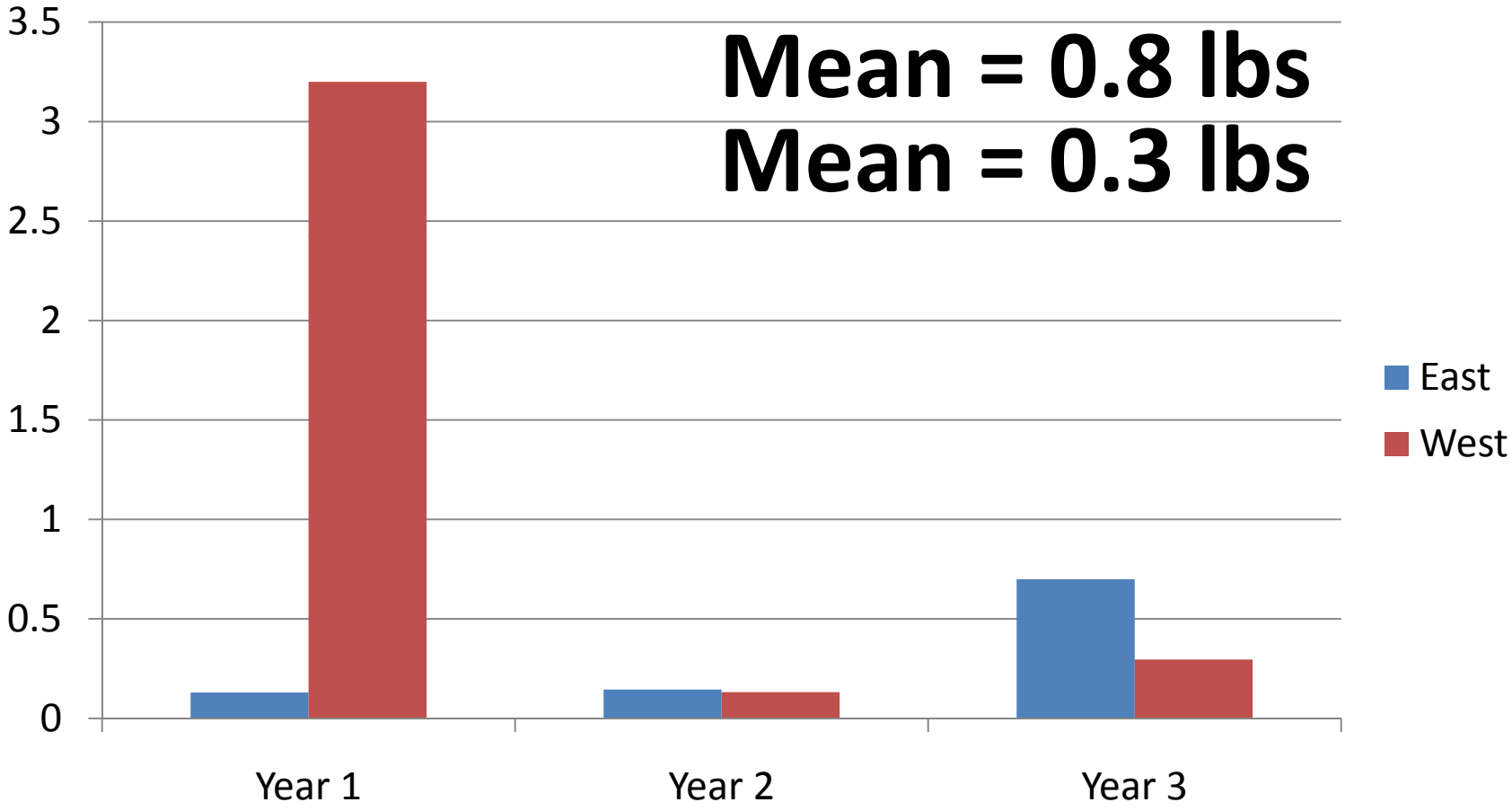

Ammonium-N (mg N/liter)
2500
2000
1500
1000
500
0
East
West
12/5/2005
1/2/2006
1/30/2006
2/27/2006
3/27/2006
4/24/2006
Year 1

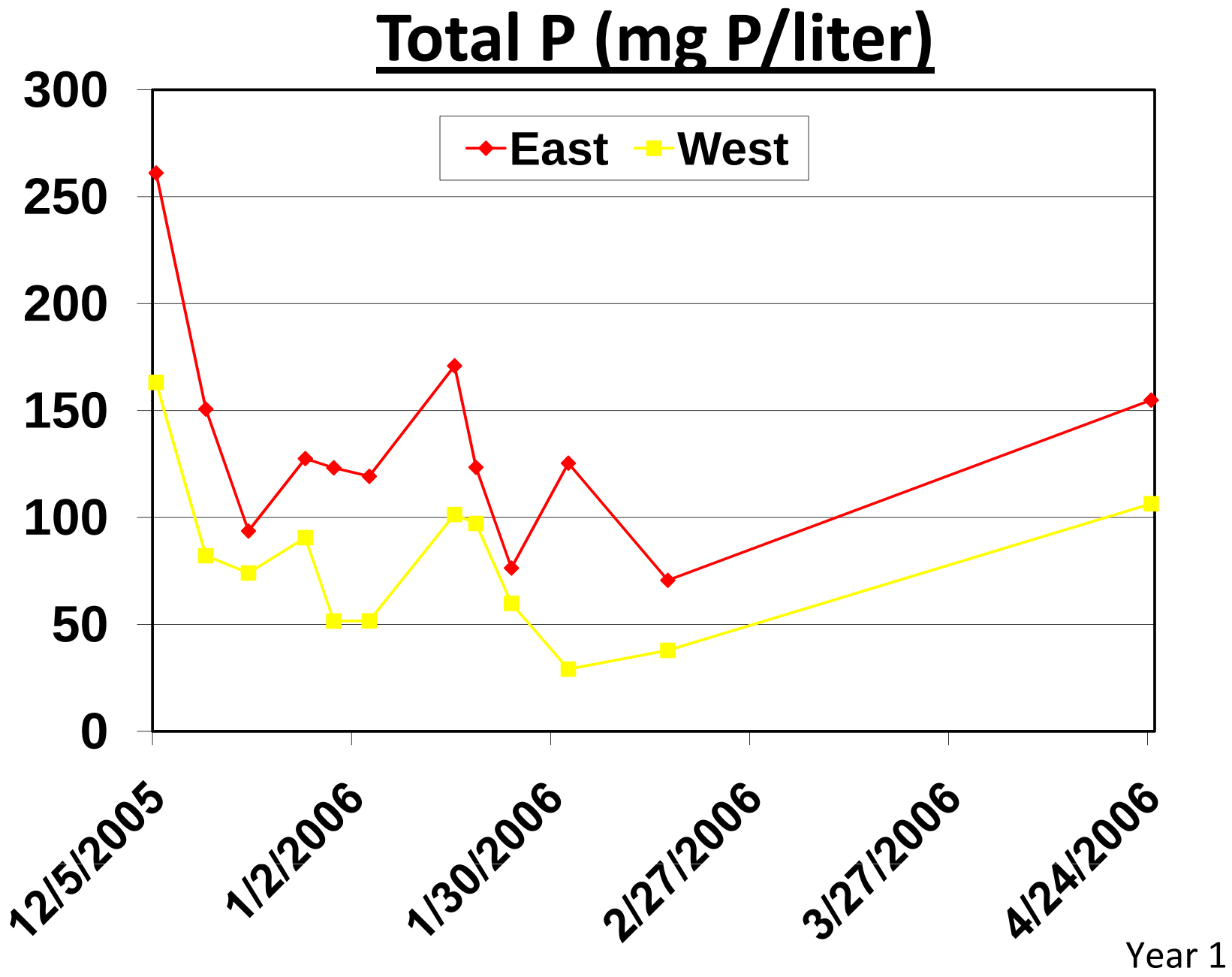
Ammonium-N (lbs) in 100’ x 18’



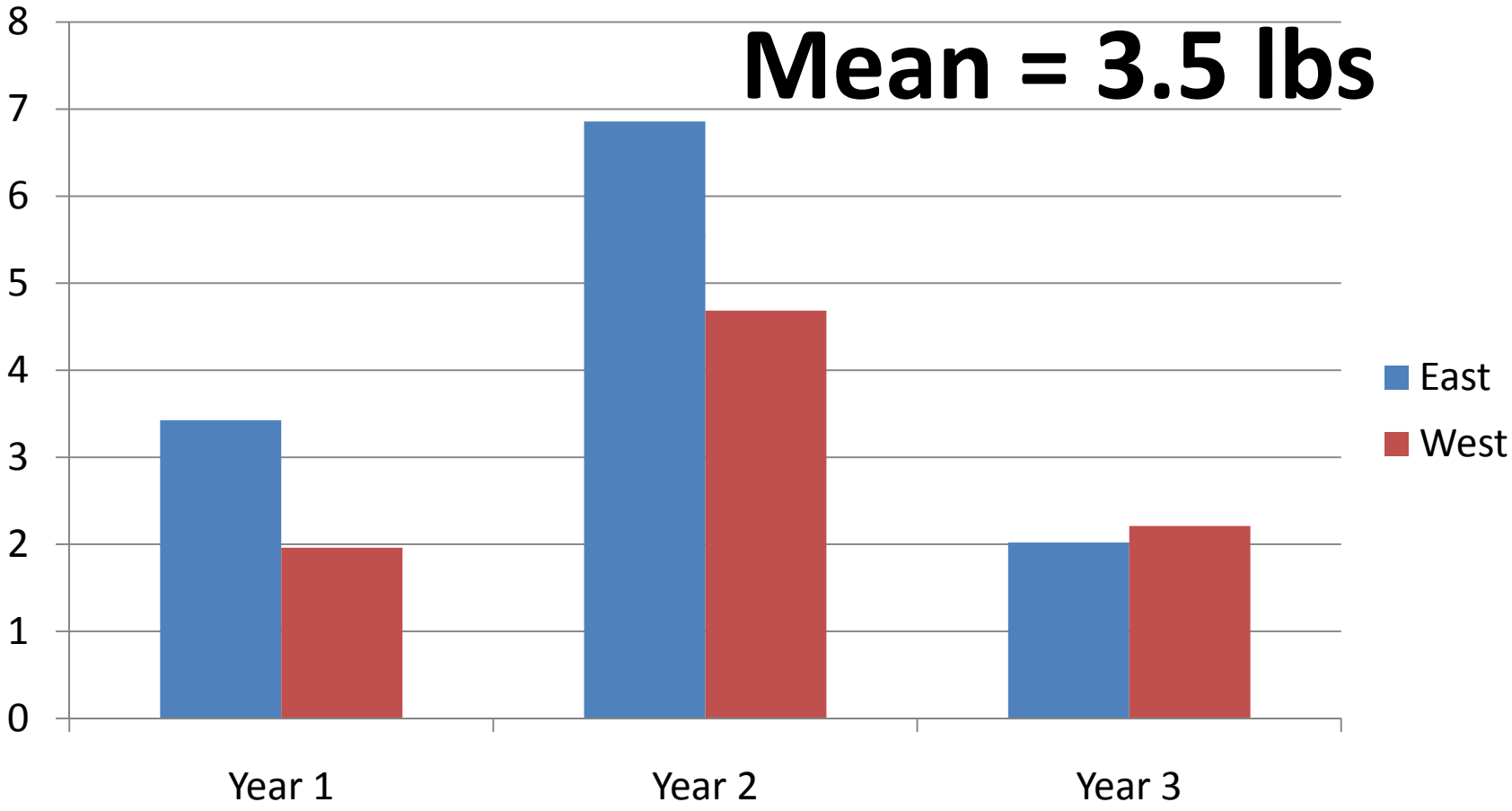

Nitrate-N (mg N/liter)
1800
1600
1400
1200
1000
800
600
400
200
0
East
West
12/5/2005
1/2/2006
1/30/2006
2/27/2006
3/27/2006
4/24/2006
Year 1

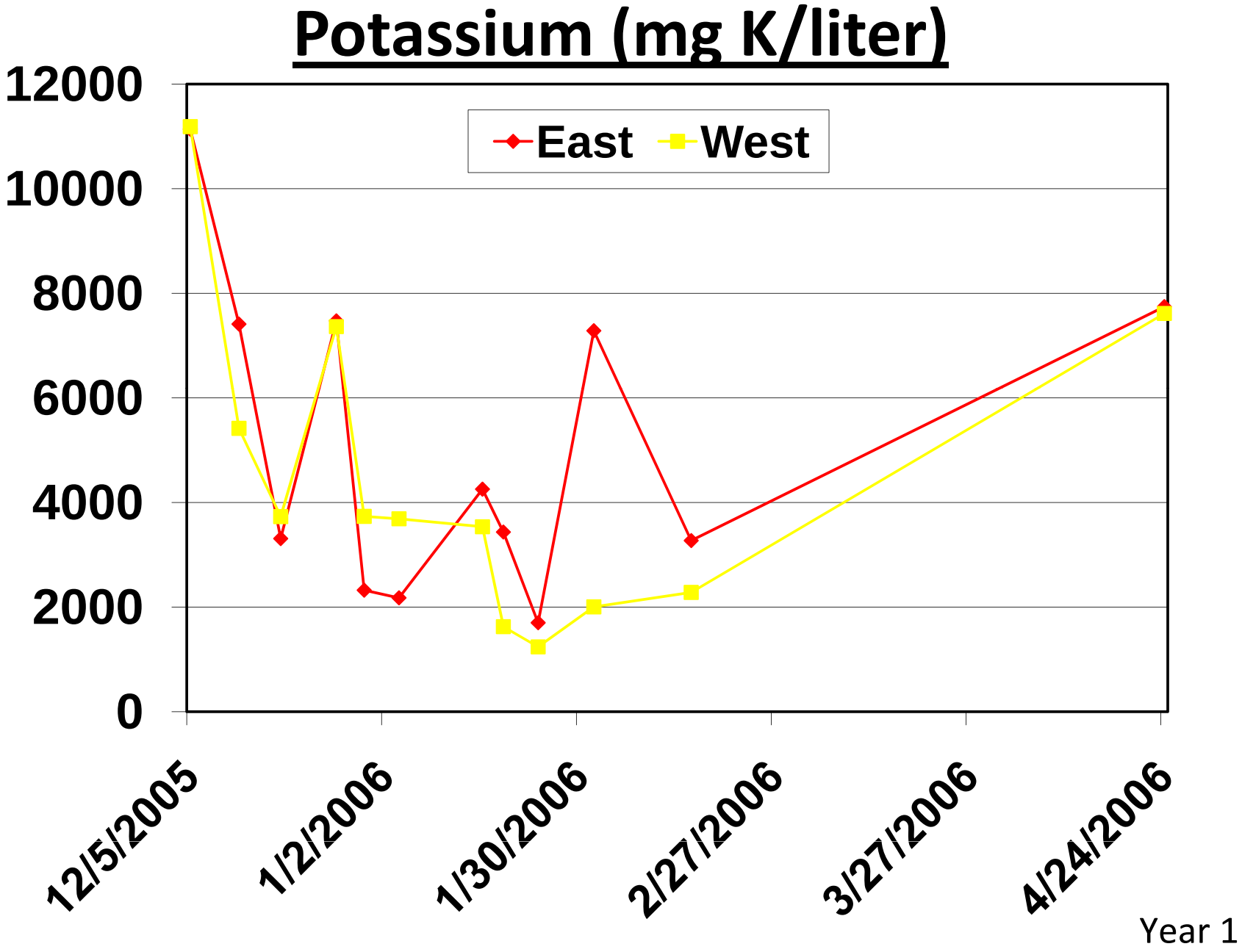
Nitrate-N (lbs) in 100’ x 18’



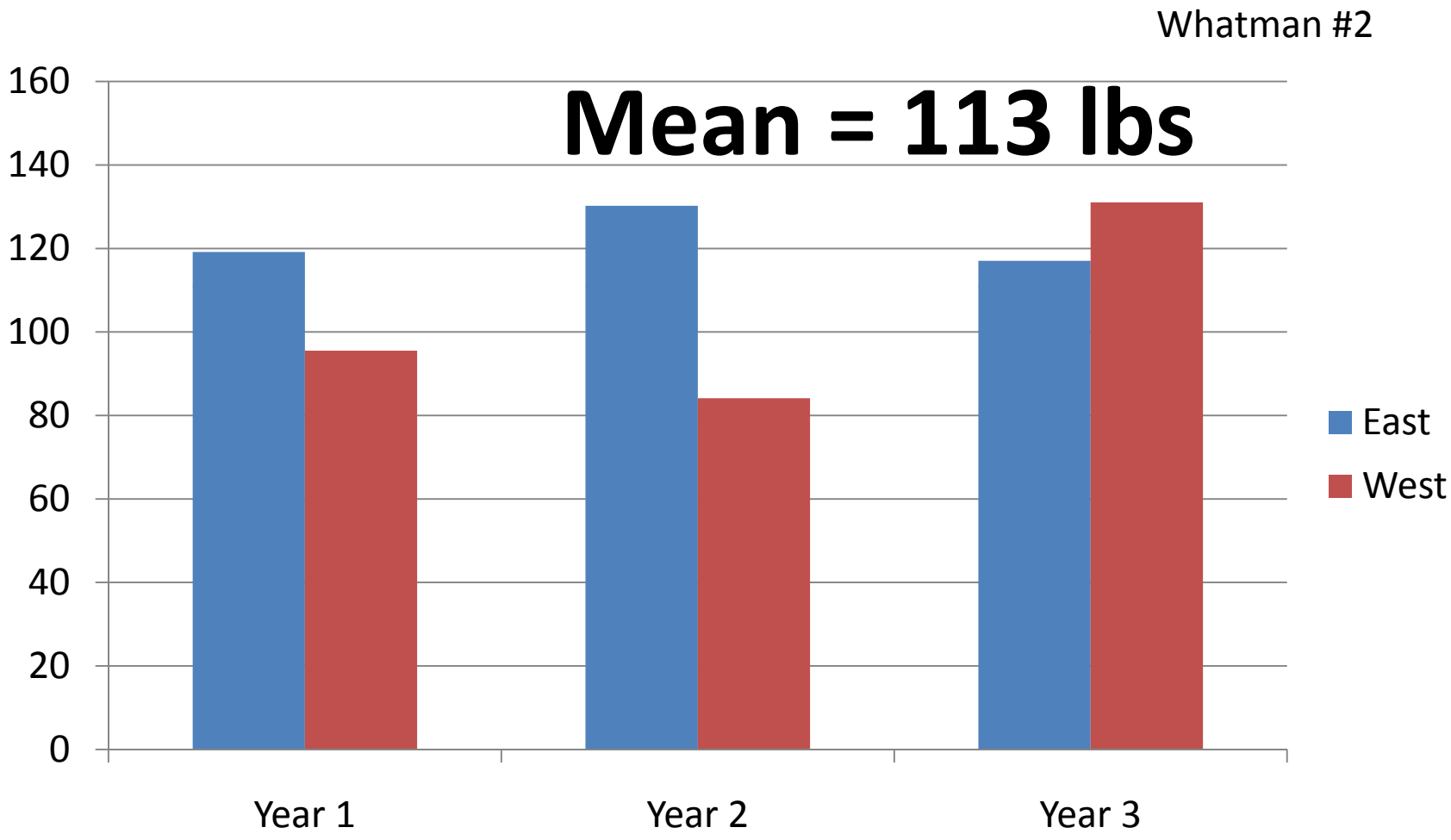

Total P (mg P/liter)
300
250
200
150
100
50
0
East
West
12/5/2005
1/2/2006
1/30/2006
2/27/2006
3/27/2006
4/24/2006
Year 1

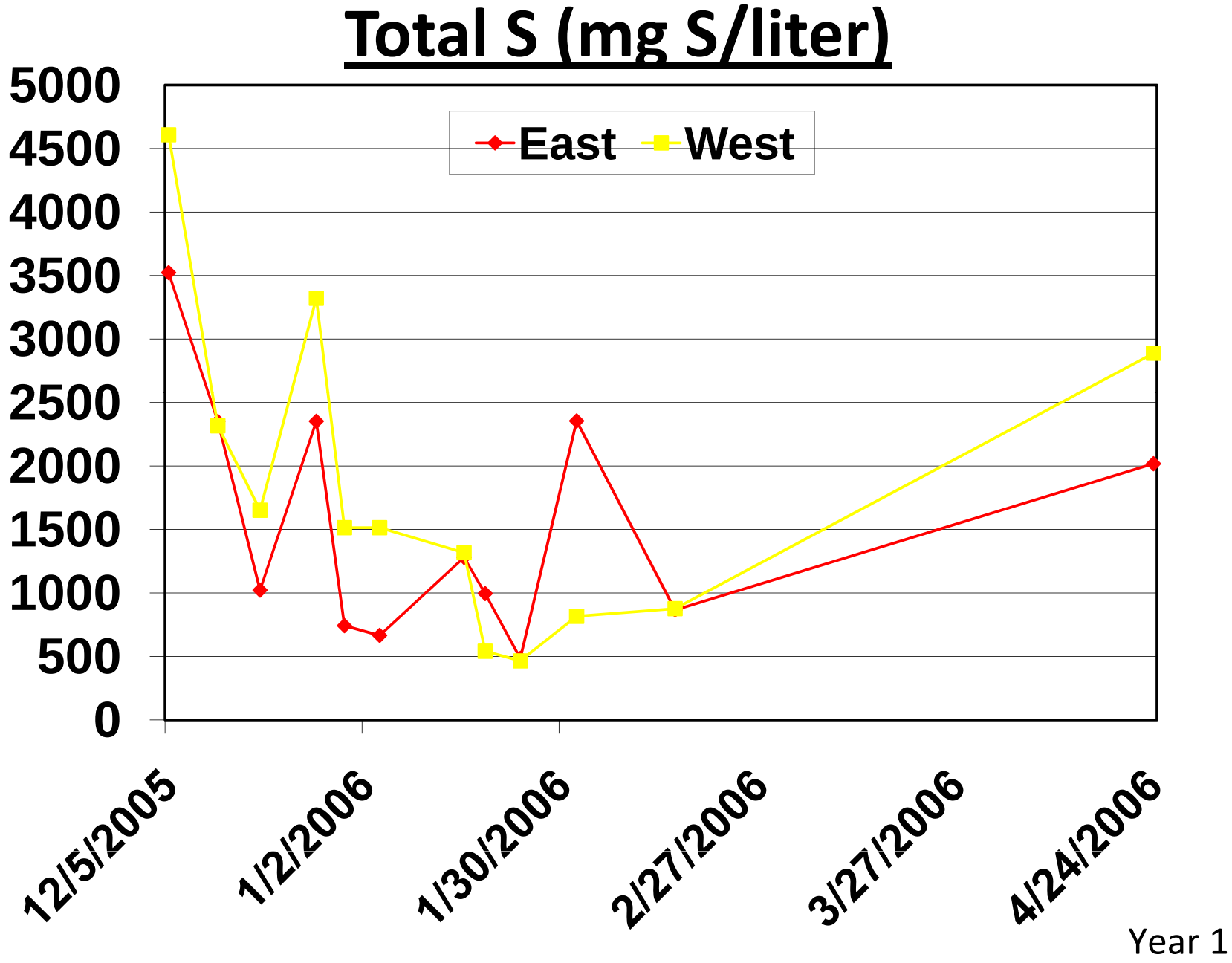
Total P (lbs) in 100’ x 18’



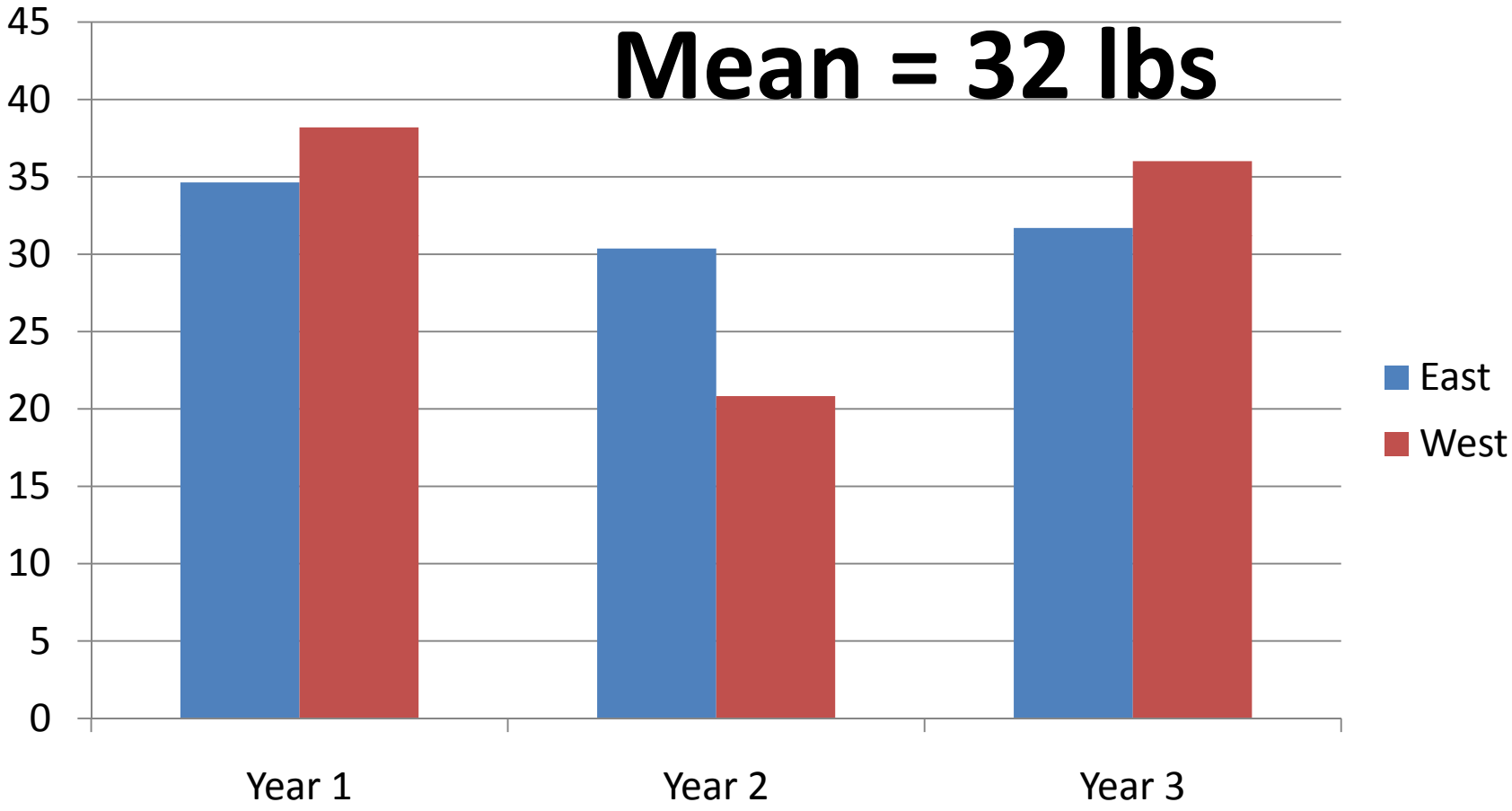

Potassium (mg K/liter)
12000
10000
8000
6000
4000
2000
0
East
West
12/5/2005
1/2/2006
1/30/2006
2/27/2006
3/27/2006
4/24/2006
Year 1

Potassium (lbs) in 100’ x 18’



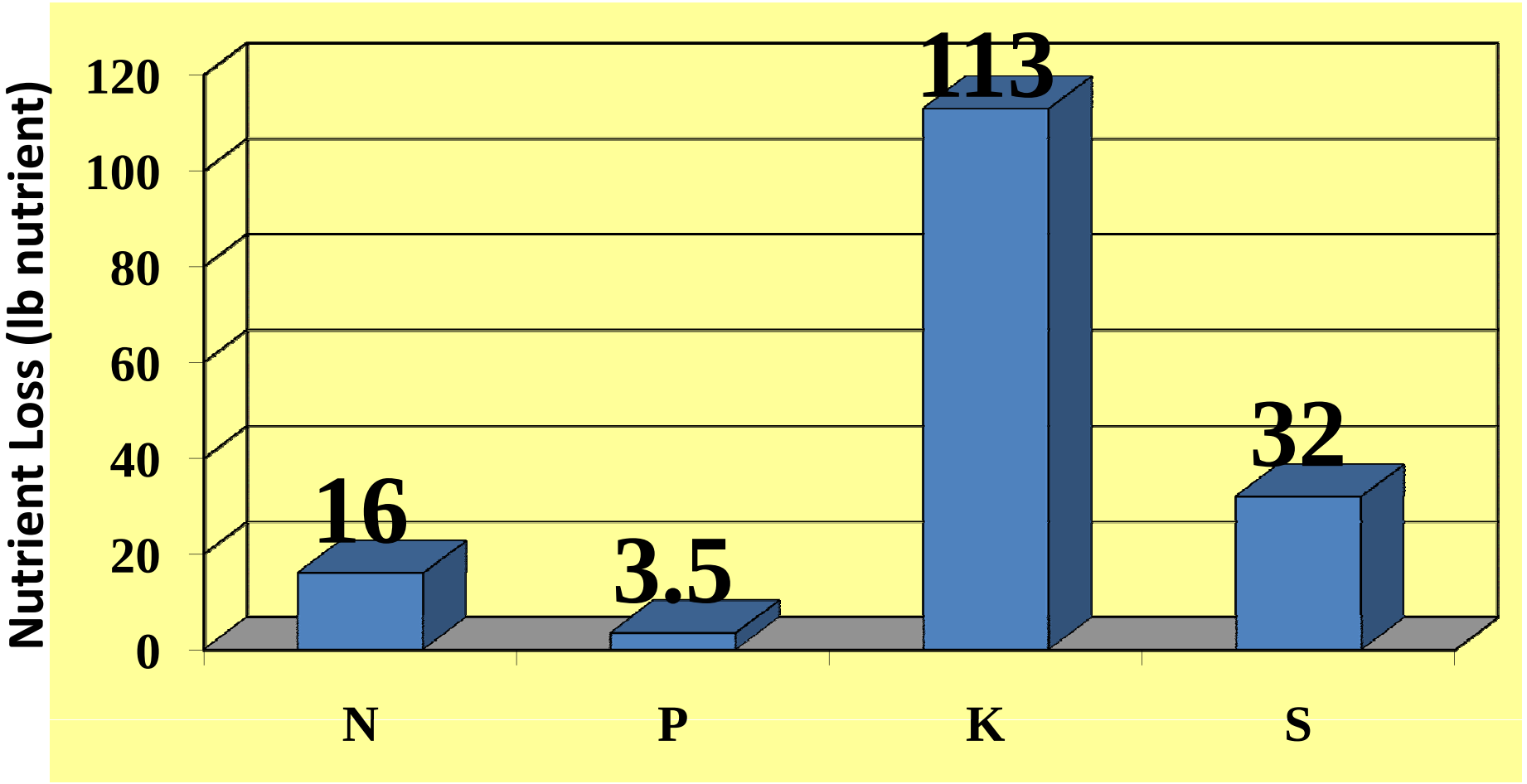

Total S (mg S/liter)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
East
West
12/5/2005
1/2/2006
1/30/2006
2/27/2006
3/27/2006
4/24/2006
Year 1

Total S (lbs) in 100’ x 18’



Nutrient Losses from Leachate

(100 ft X 18 ft Pile Size @6’ height)

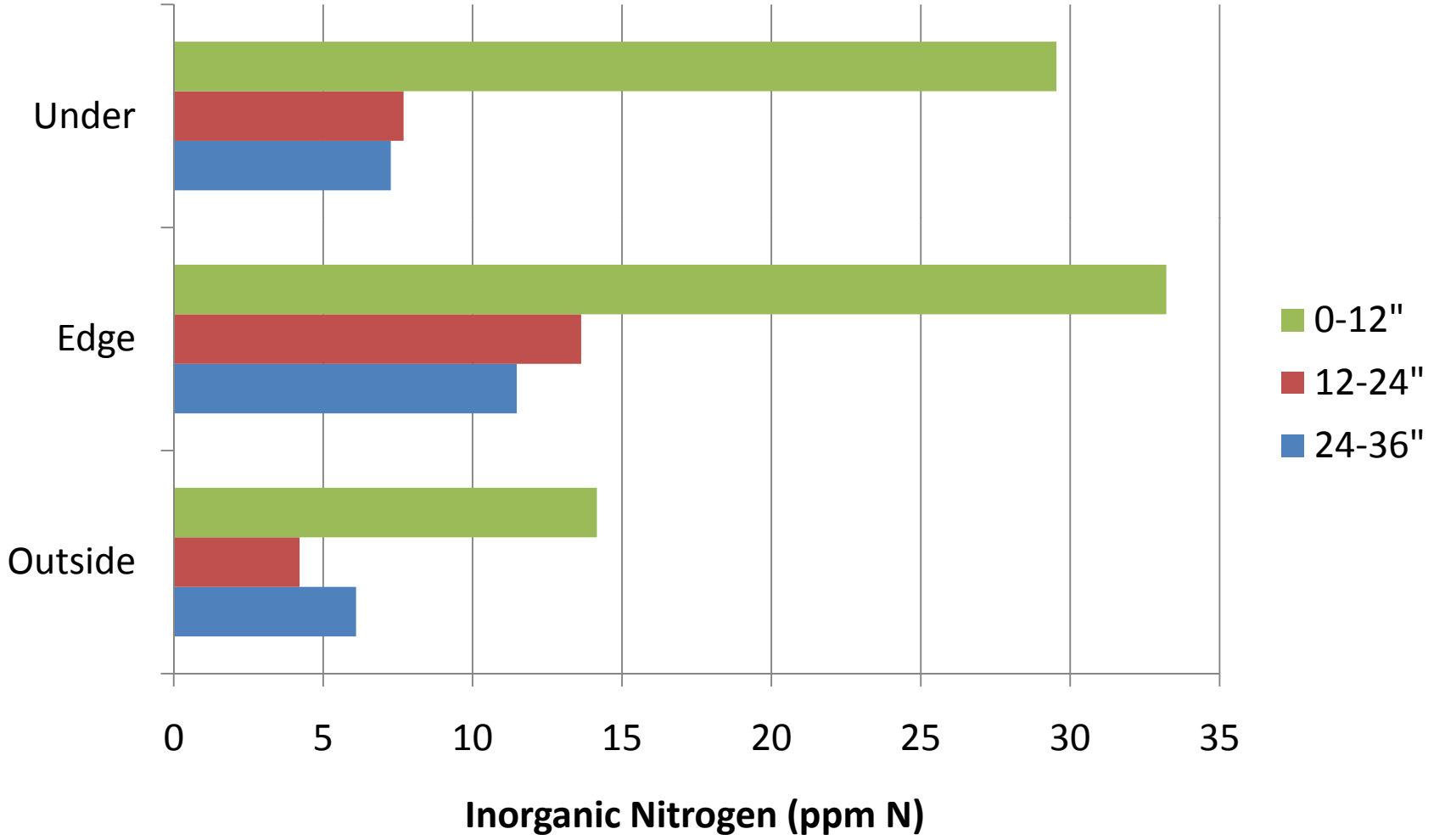


DATA
Soil

9 Nov = 0.04”
10 Nov = 0.10”
17 Nov = 0.80”

15-Day Treatment

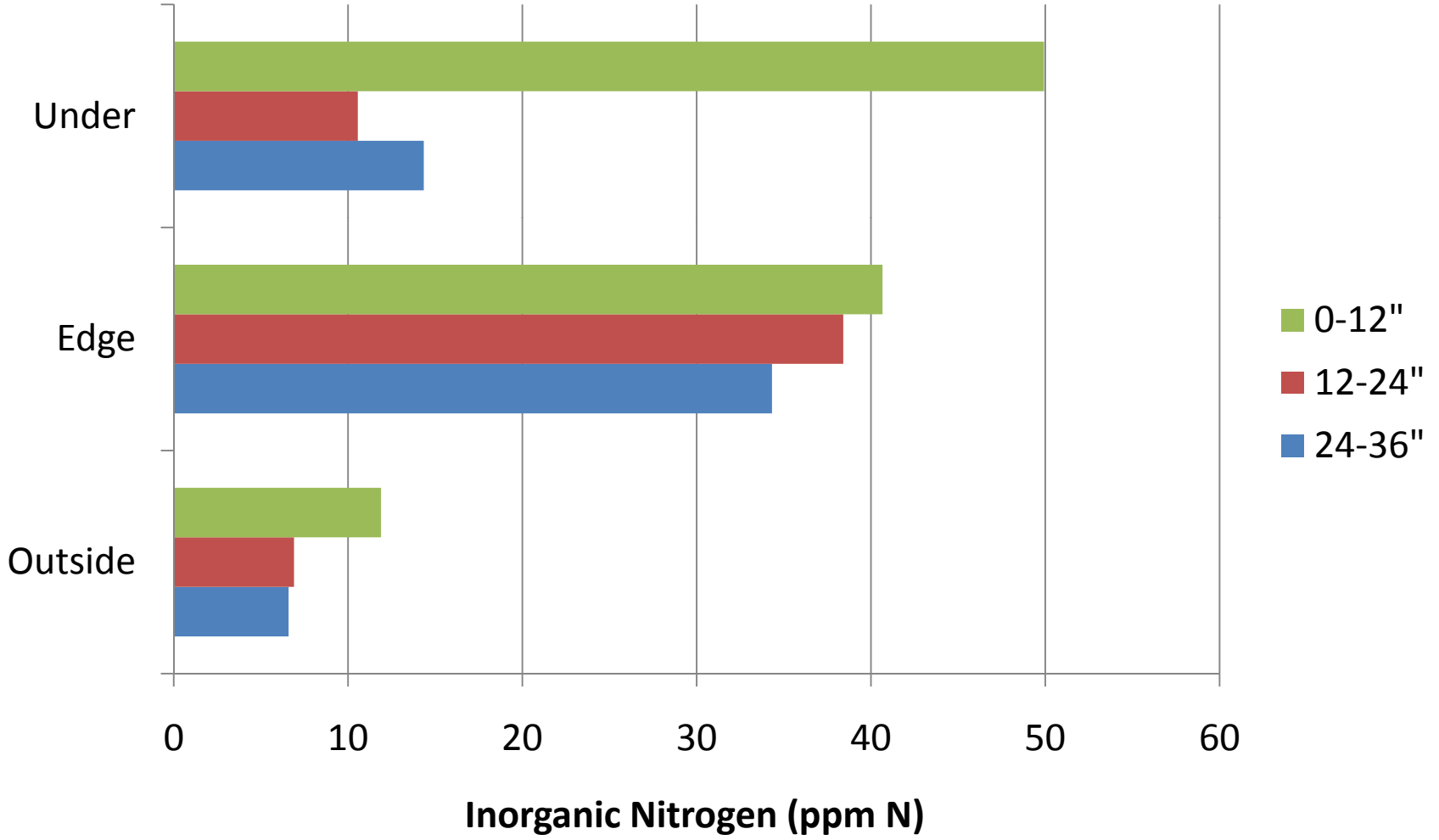
Three rainfall events = total of 0.94 inches; ZERO runoff events



17 Nov 2005

185-Day Treatment

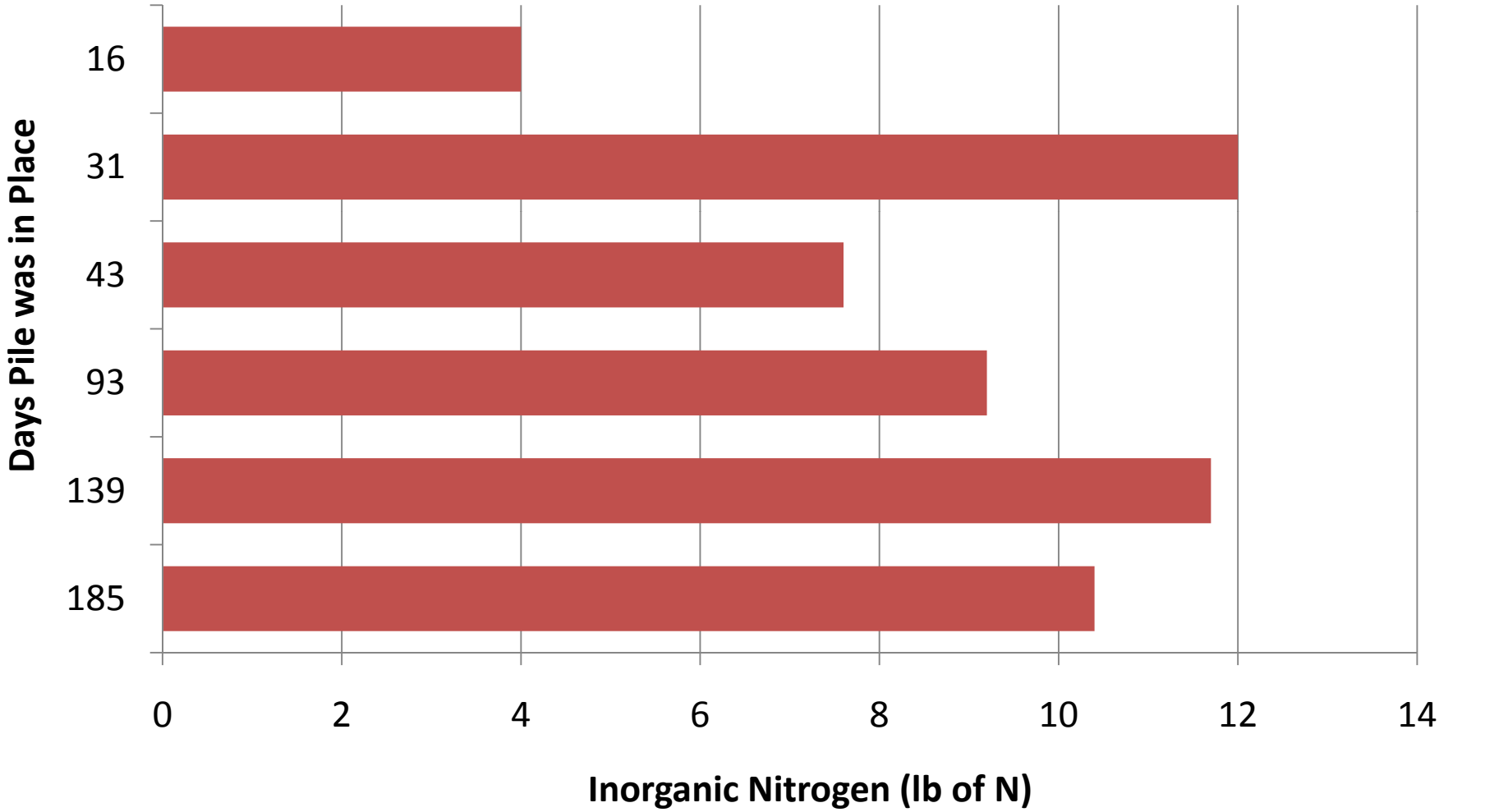
Eighteen rainfall events = total of 12.4 inches



5 May 2006

Loading to 3’ Depth

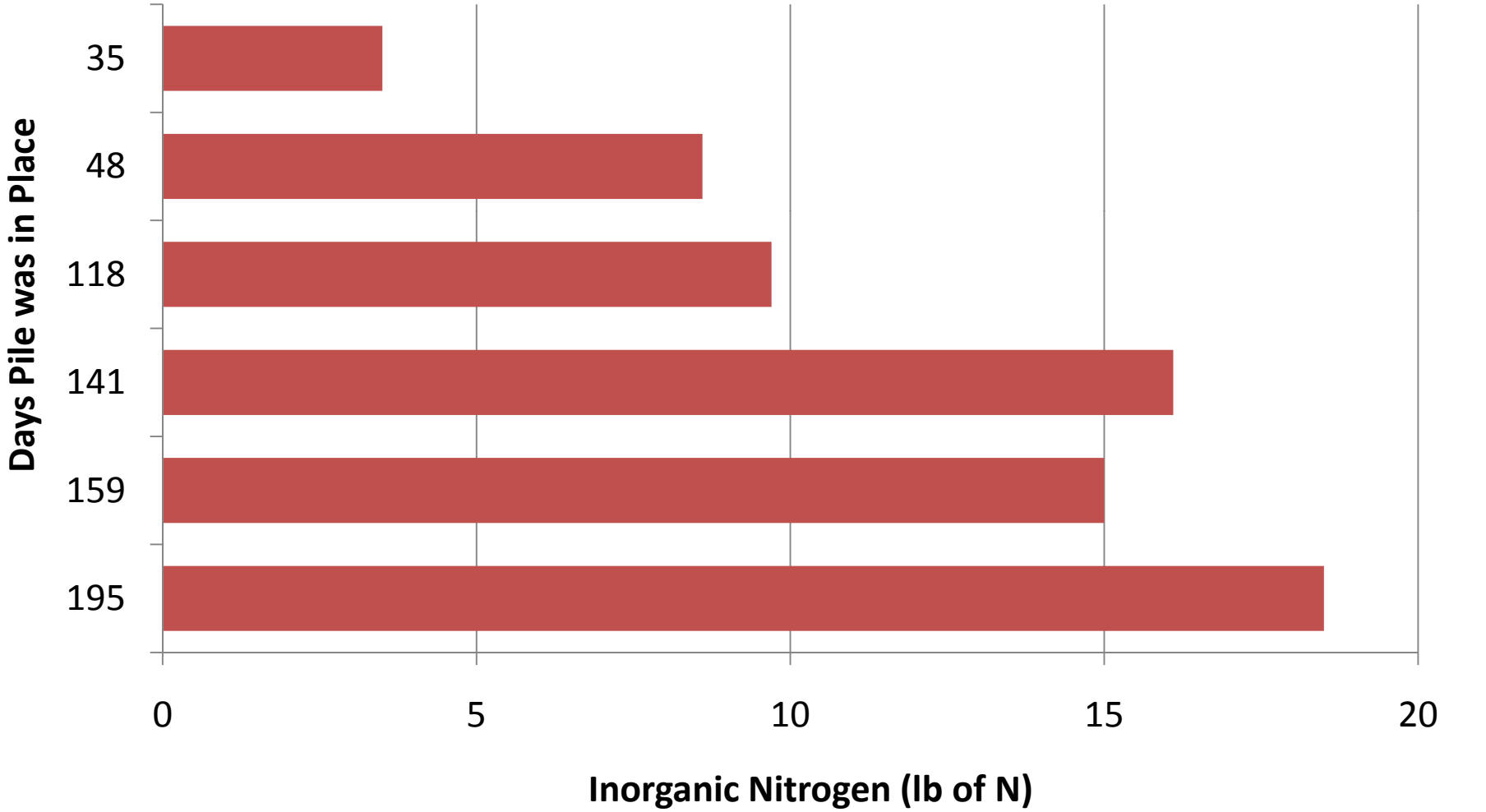
Assumed Pile Size: 100 ft X 18 ft



Year 1

Loading to 4’ Depth

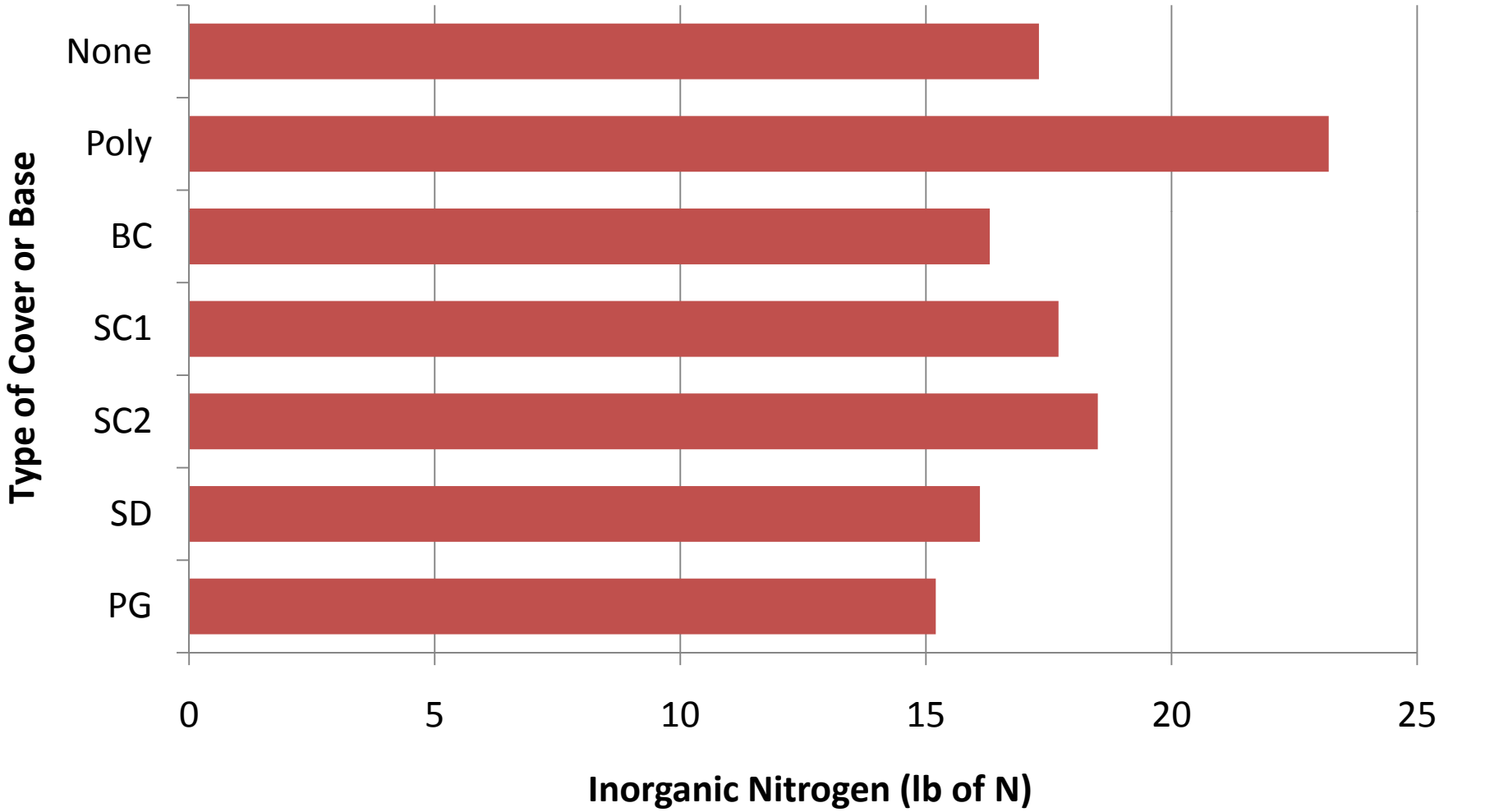
Assumed Pile Size: 100 ft X 18 ft



Year 2

Loading to 3’ Depth

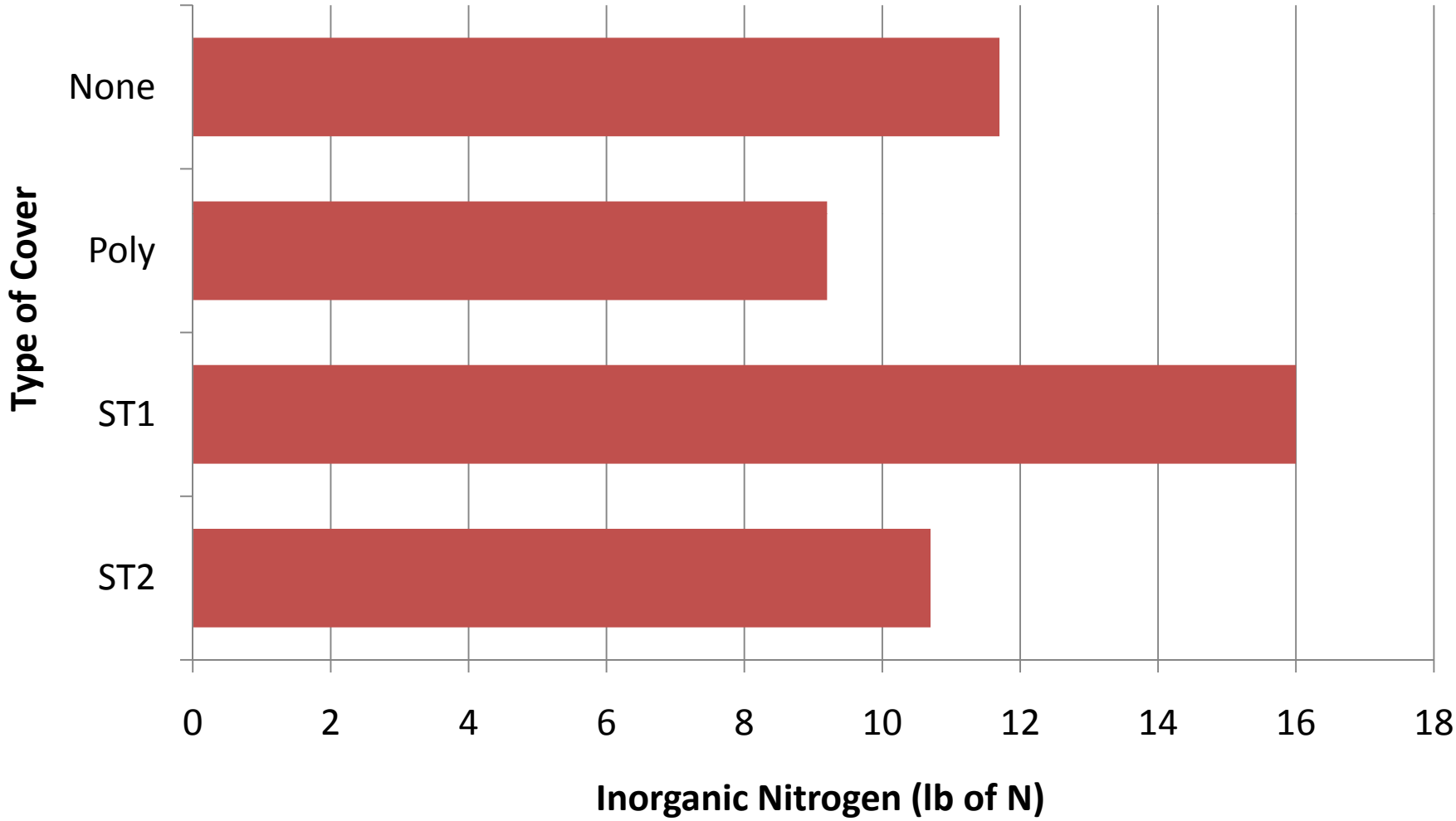
Assumed Pile Size: 100 ft X 18 ft



Year 1

Loading to 4’ Depth

Assumed Pile Size: 100 ft X 18 ft

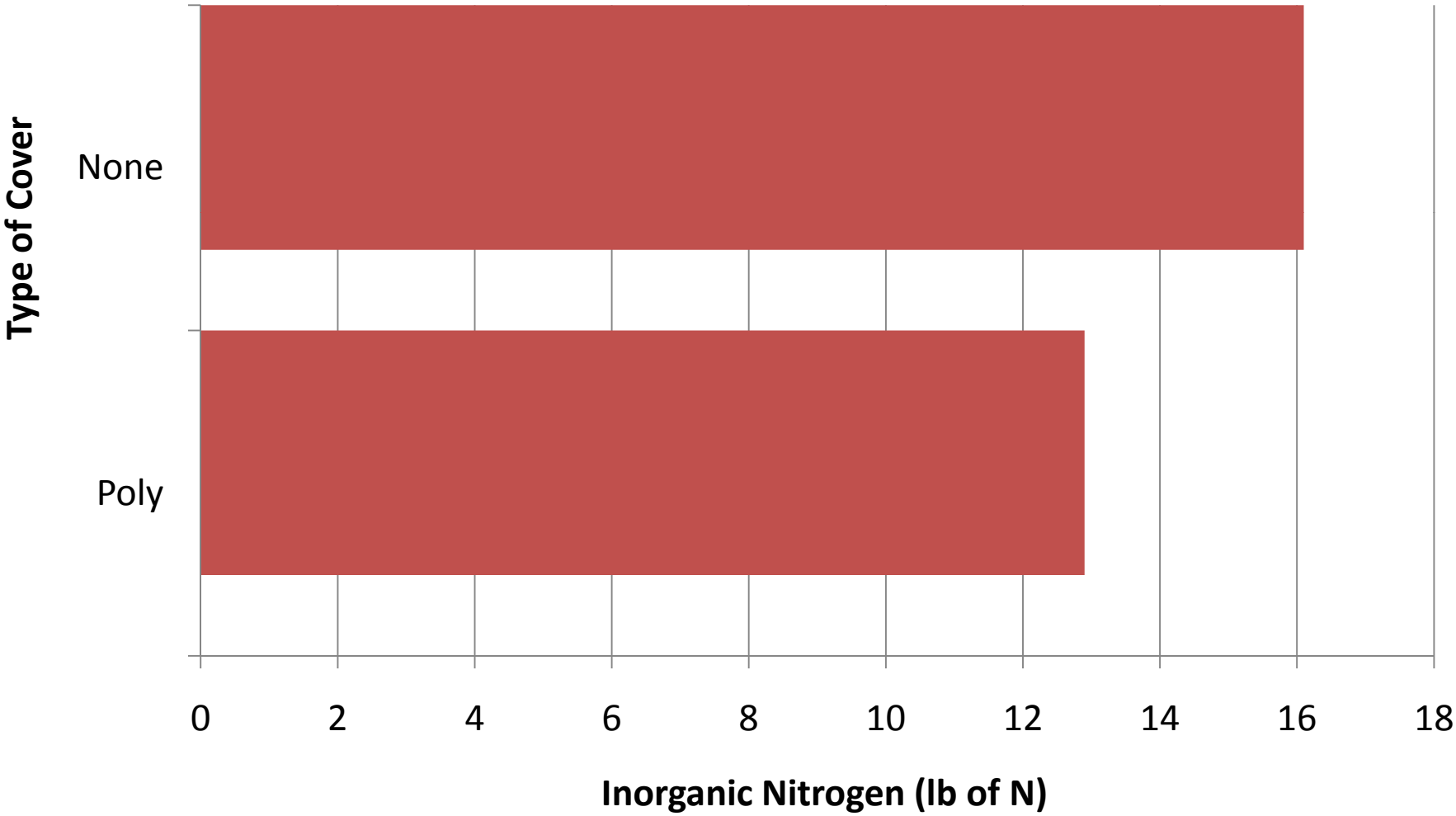


Pile in place for 123 days

Year 2

POLY vs NO COVER (4 Reps)

Assumed Pile Size: 100 ft X 18 ft

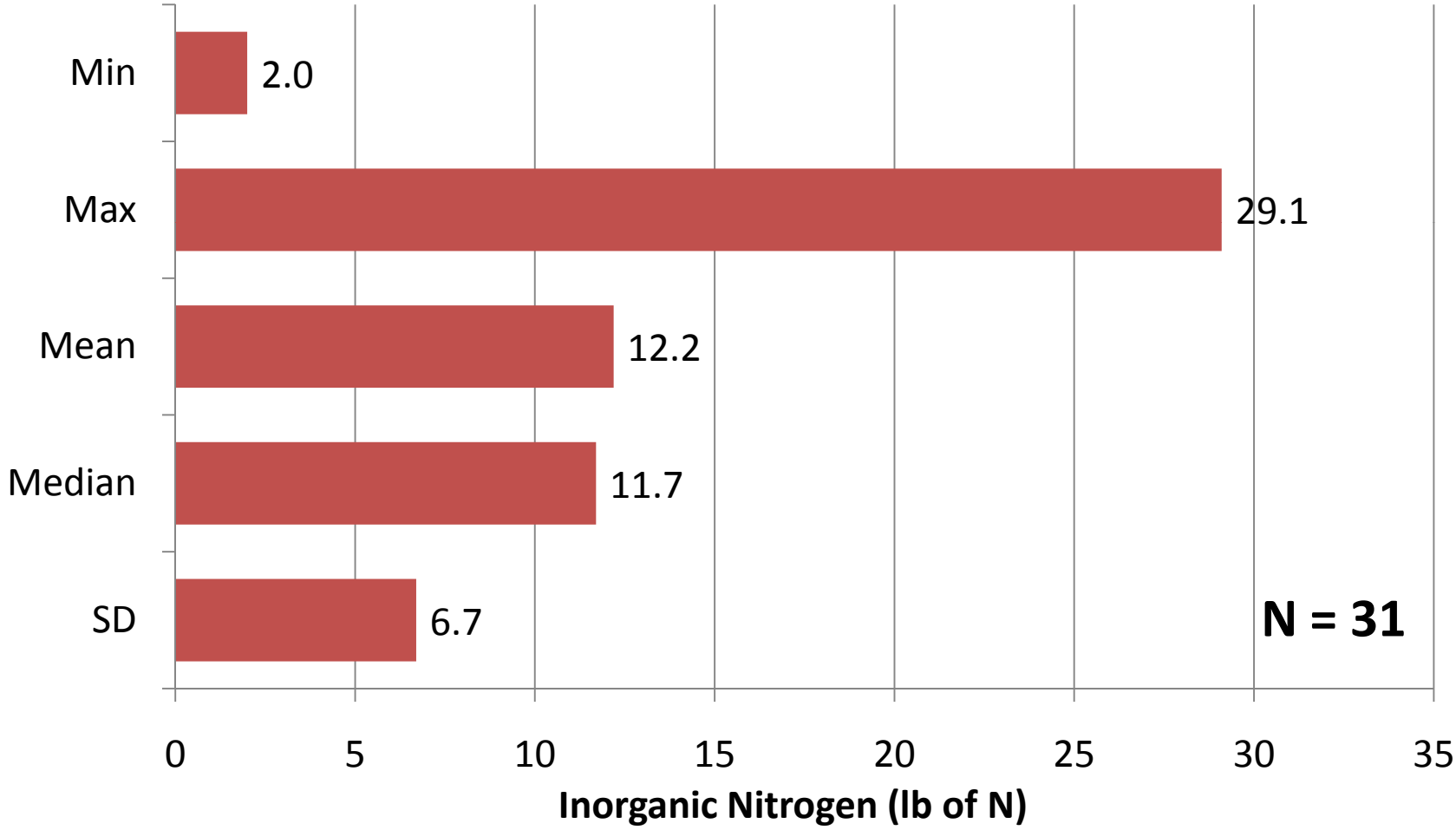


Piles in place for at least 120 days

3 Years/4 sites

Range in Values Across All Sites

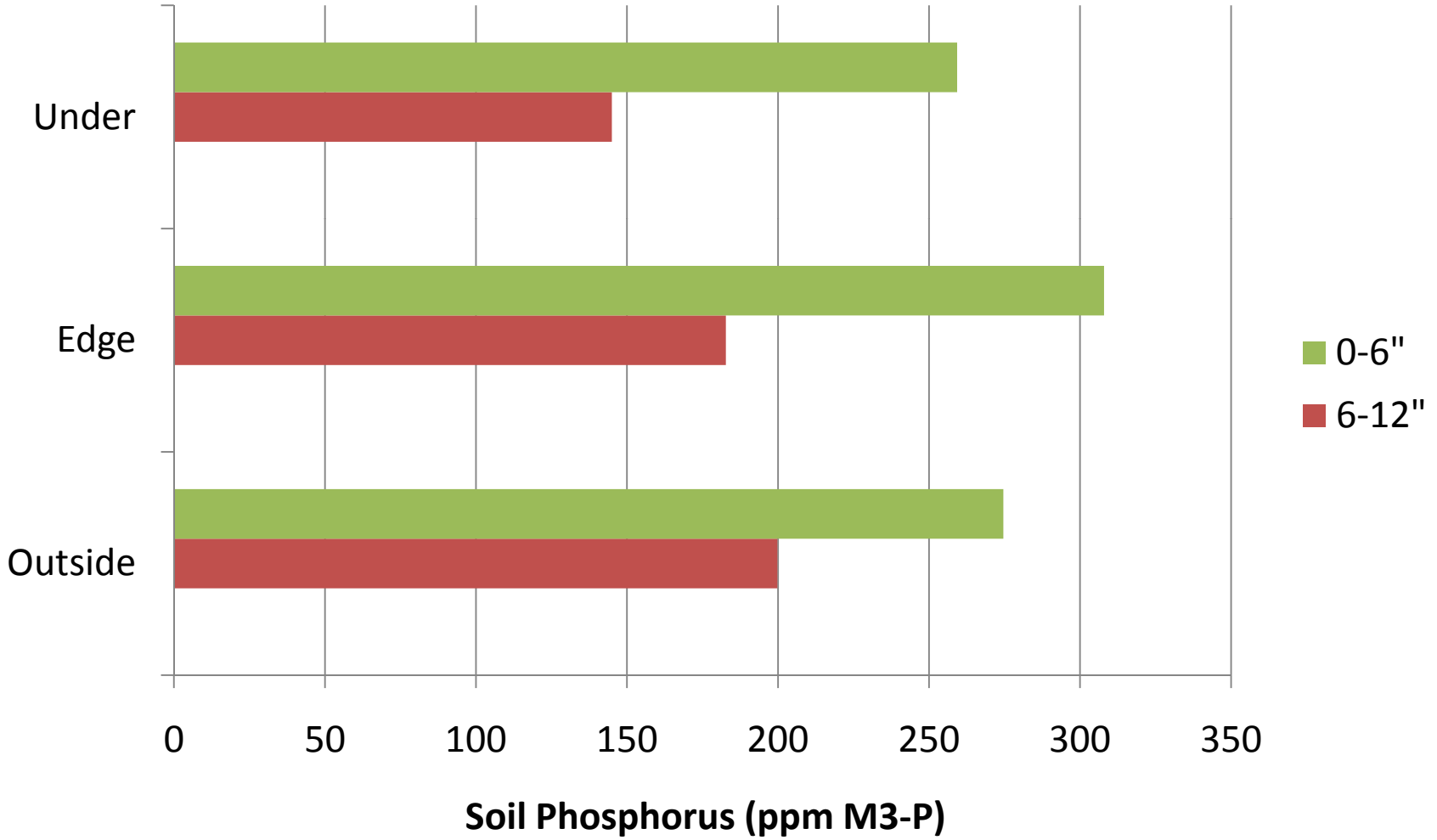
Assumed Pile Size: 100 ft X 18 ft



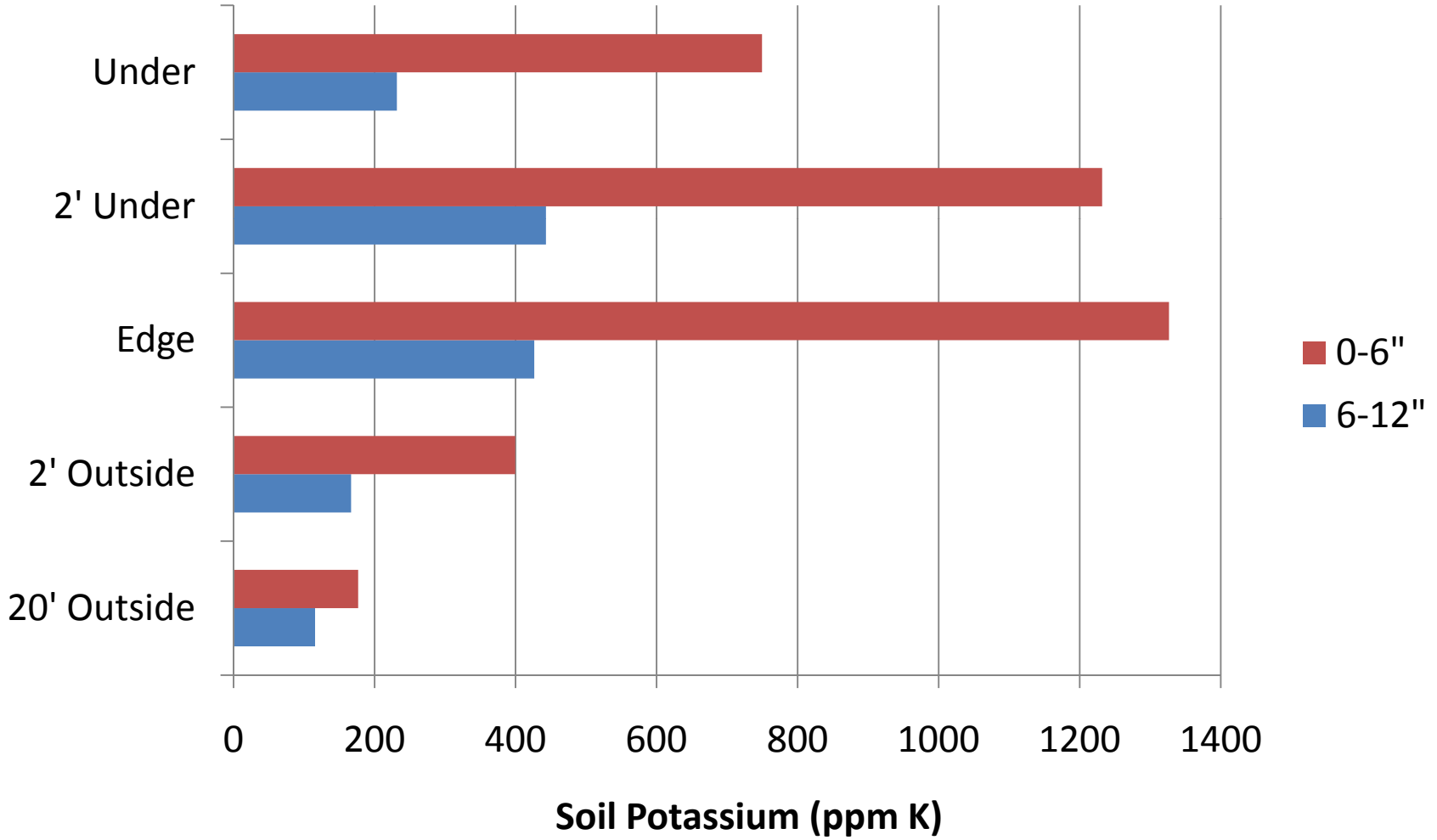
Piles in place for at least 120 days

Pile would contain about 100 tons

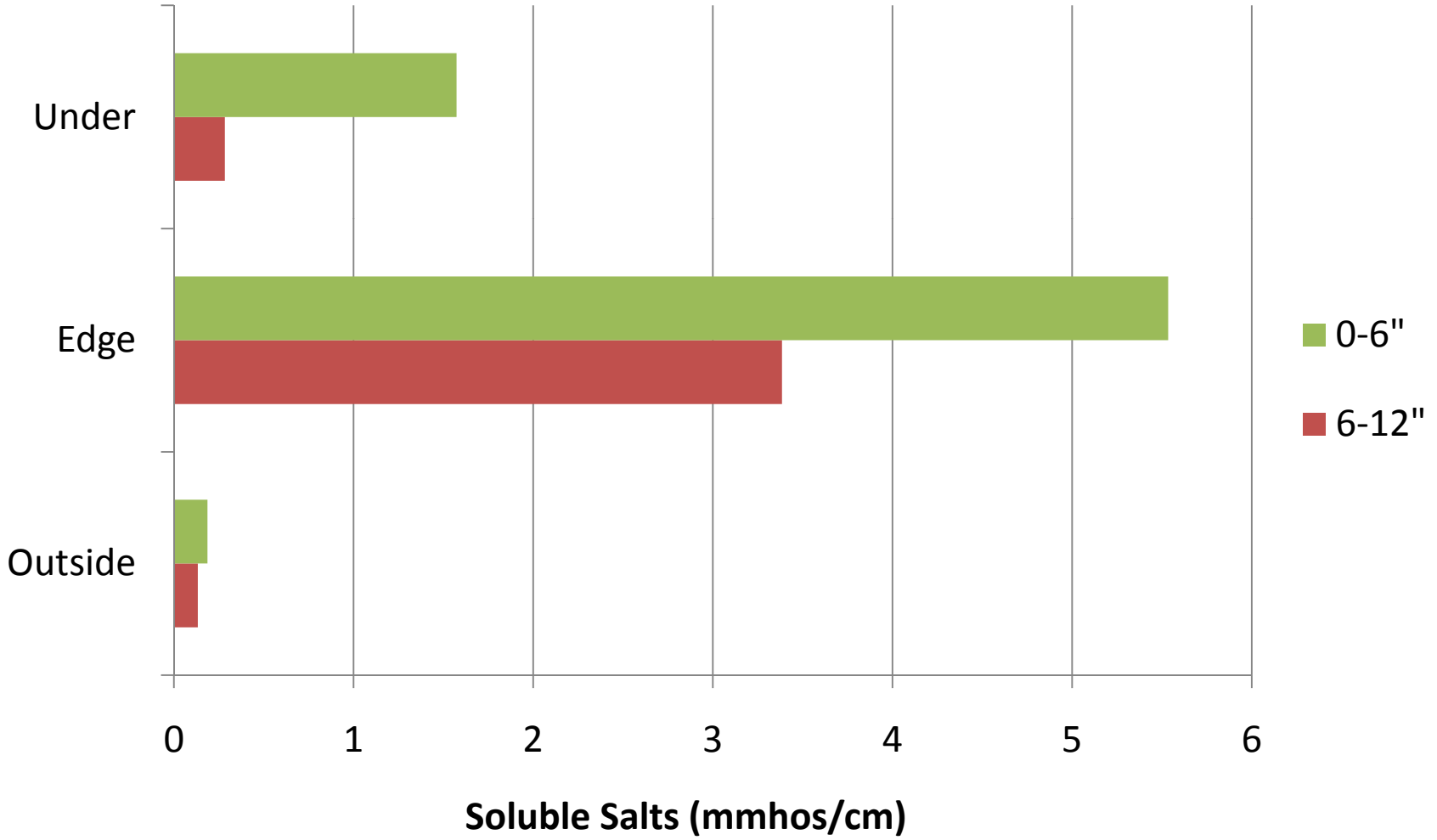
185-Day Treatment – 0 days



195-Day Treatment – Day 0



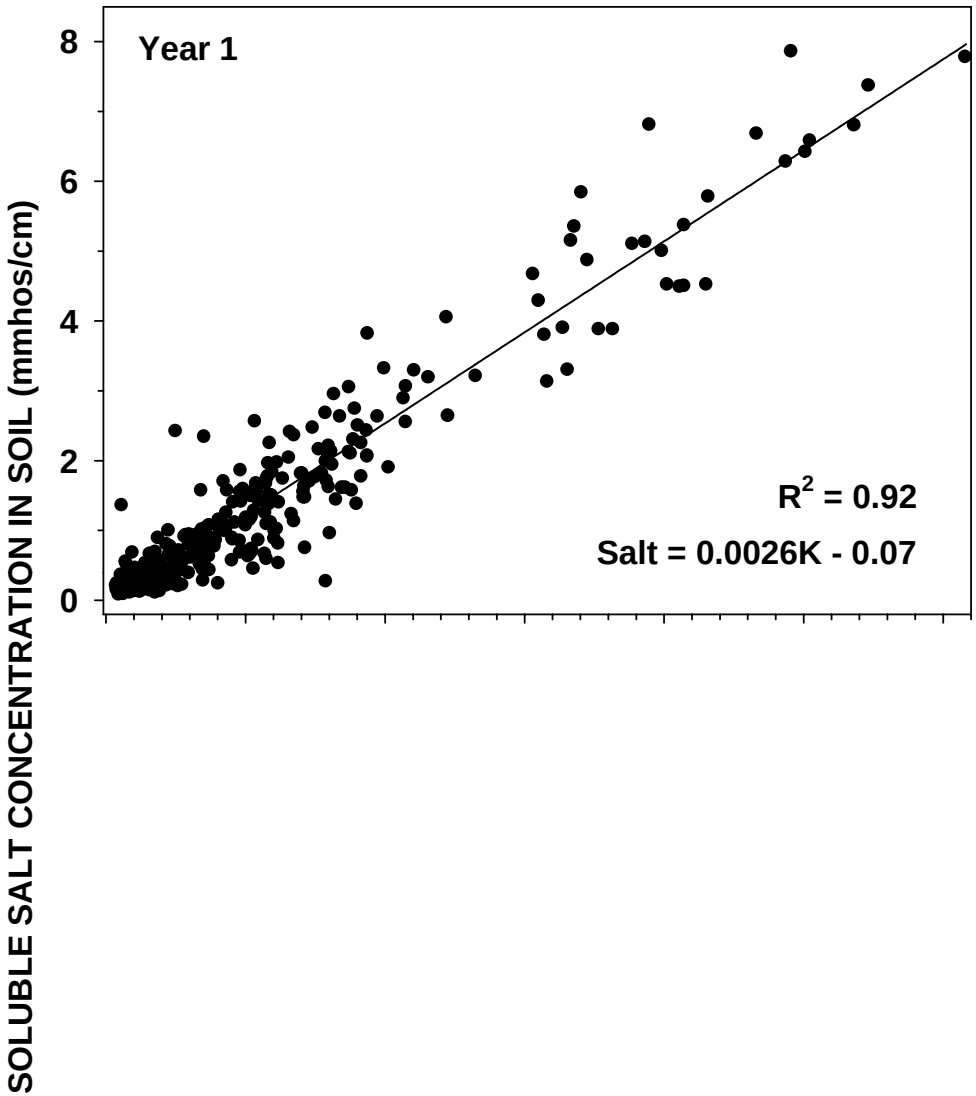
No Cover – Day 0

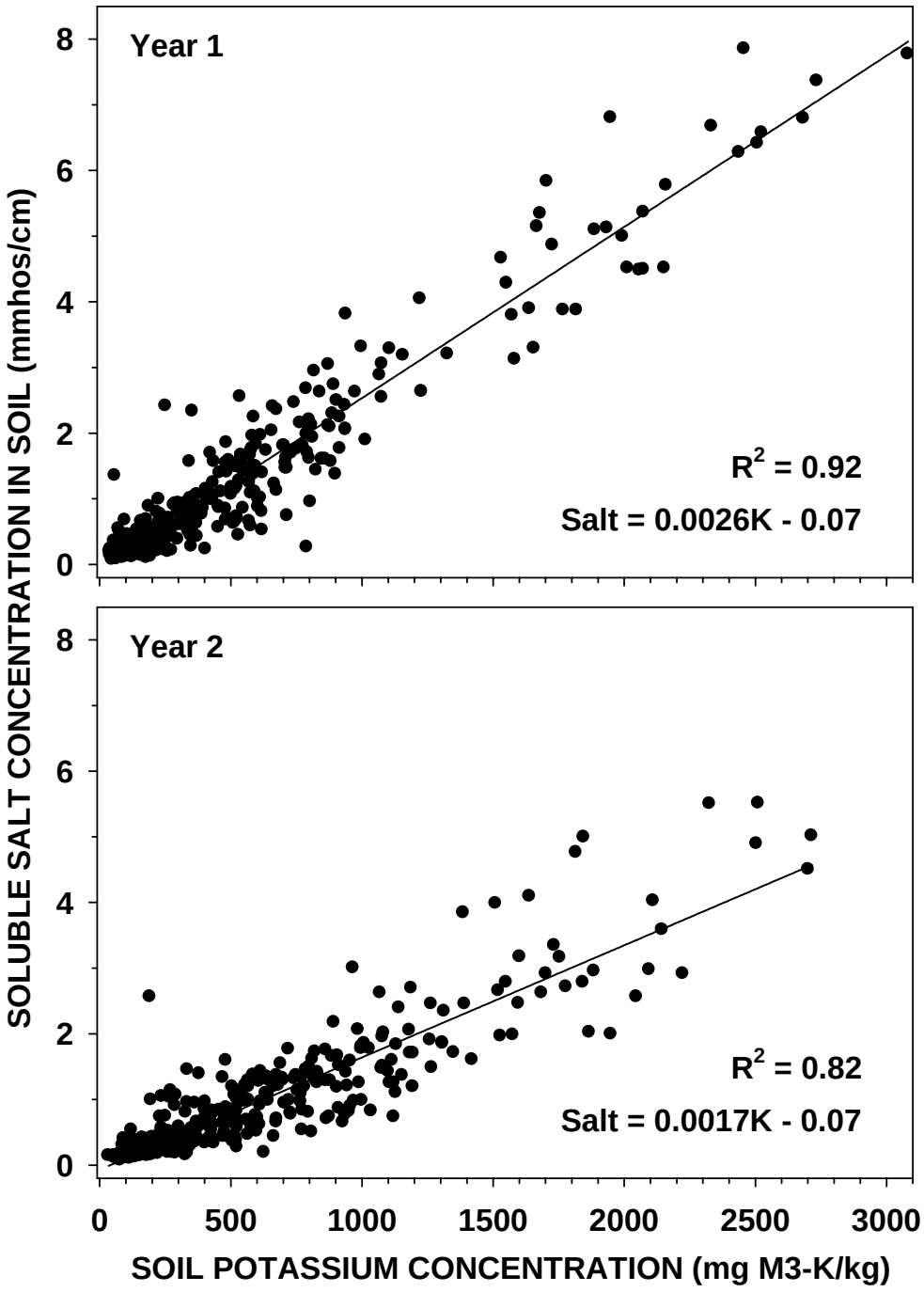


SOLUBLE SALT CONCENTRATION IN SOIL (mmhos/cm)

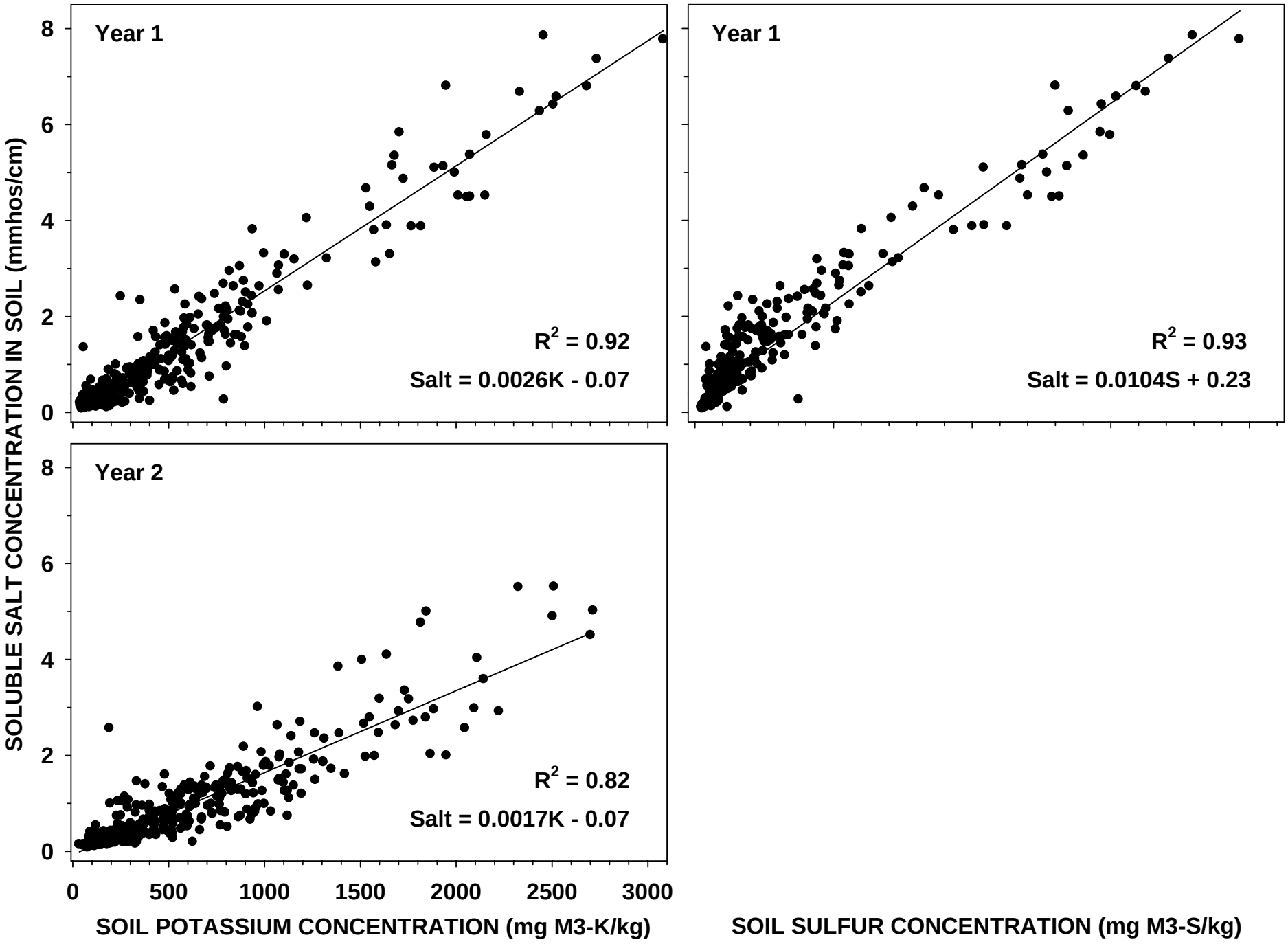
SOIL POTASSIUM CONCENTRATION (mg M3-K/kg)

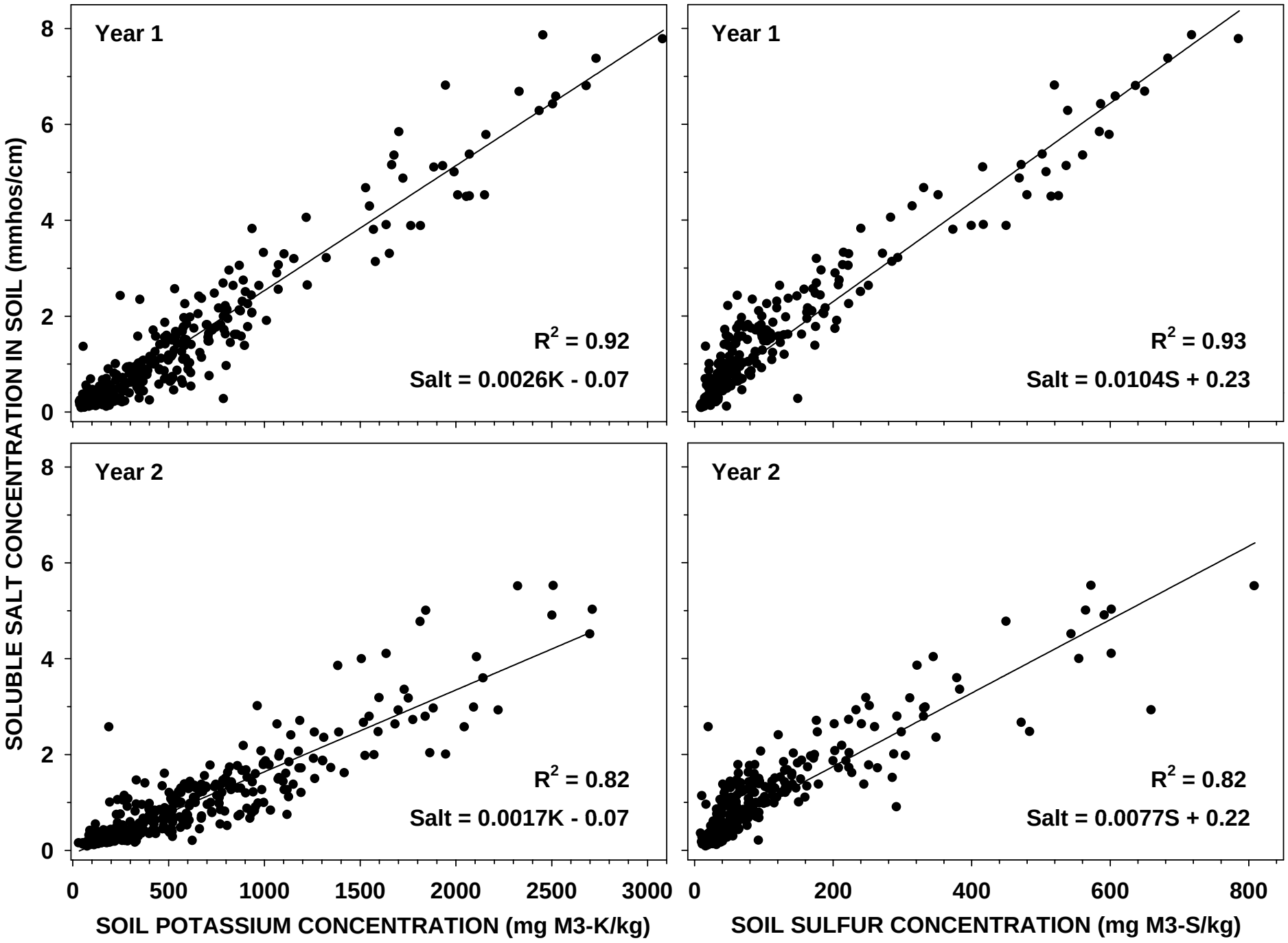
SOIL SULFUR CONCENTRATION (mg M3-S/kg)


Year 1
8
6
4
2
0
R^2 = 0.92
Salt = 0.0026K - 0.07
SOLUBLE SALT CONCENTRATION IN SOIL (mmhos/cm)
SOIL POTASSIUM CONCENTRATION (mg M3-K/kg)
SOIL SULFUR CONCENTRATION (mg M3-S/kg)

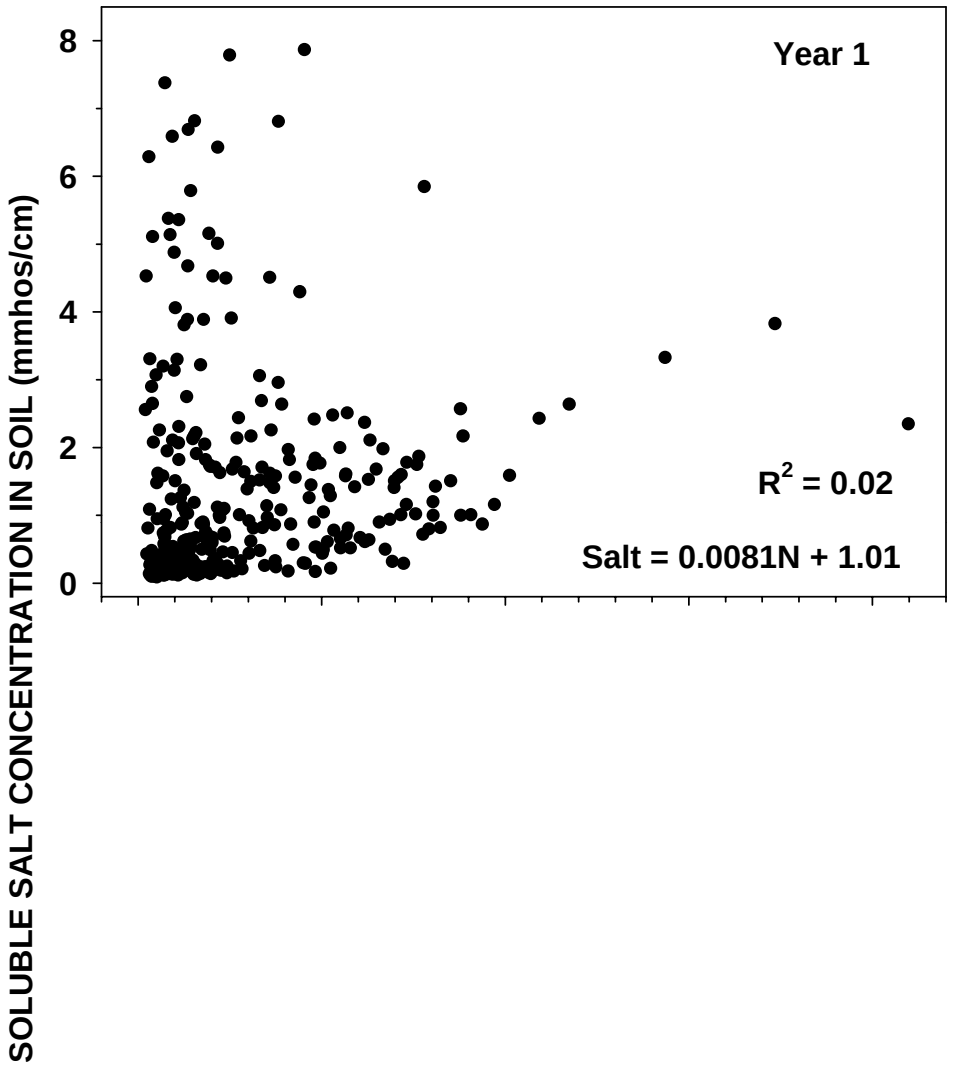


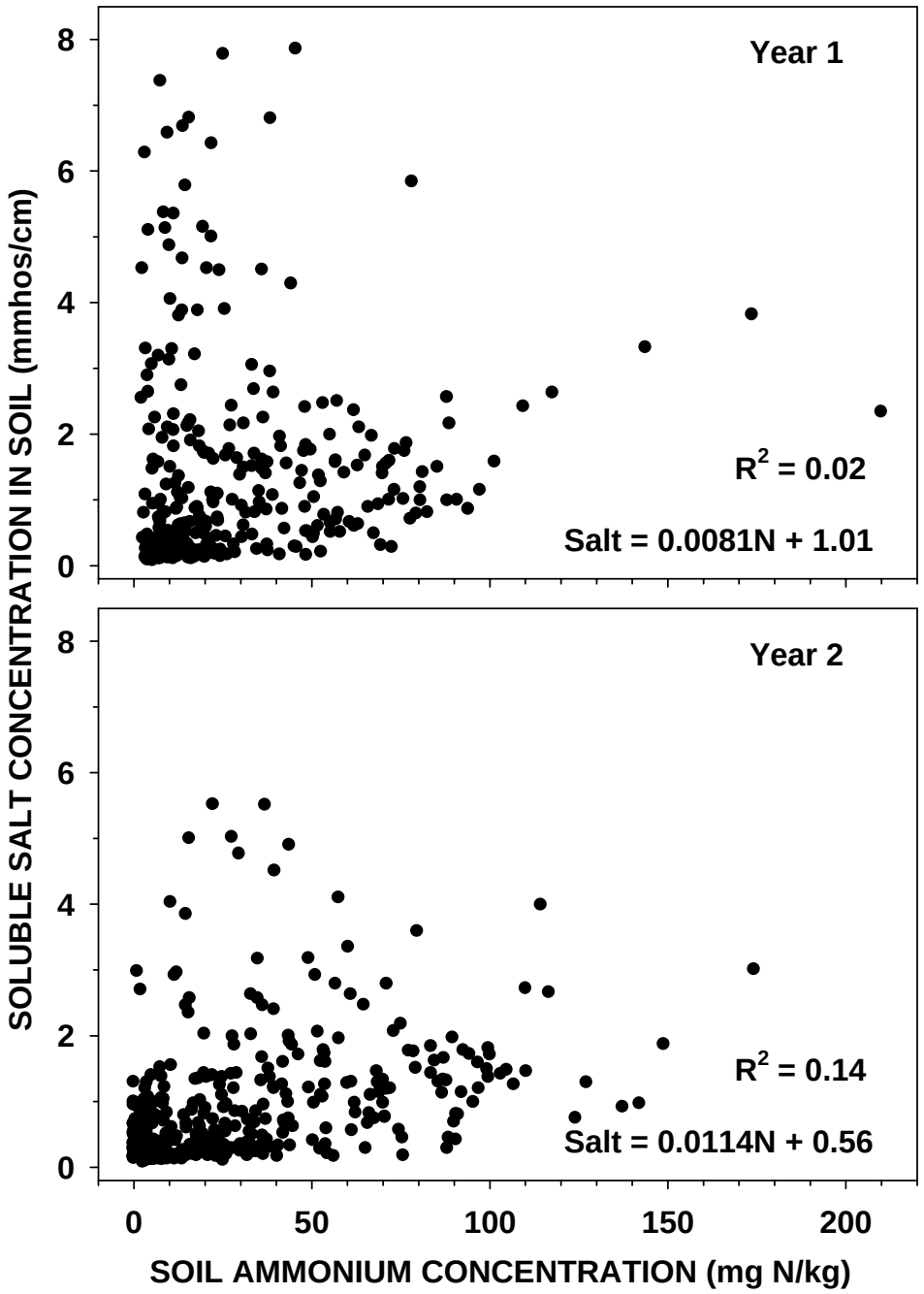
SOIL SULFUR CONCENTRATION (mg M3-S/kg)

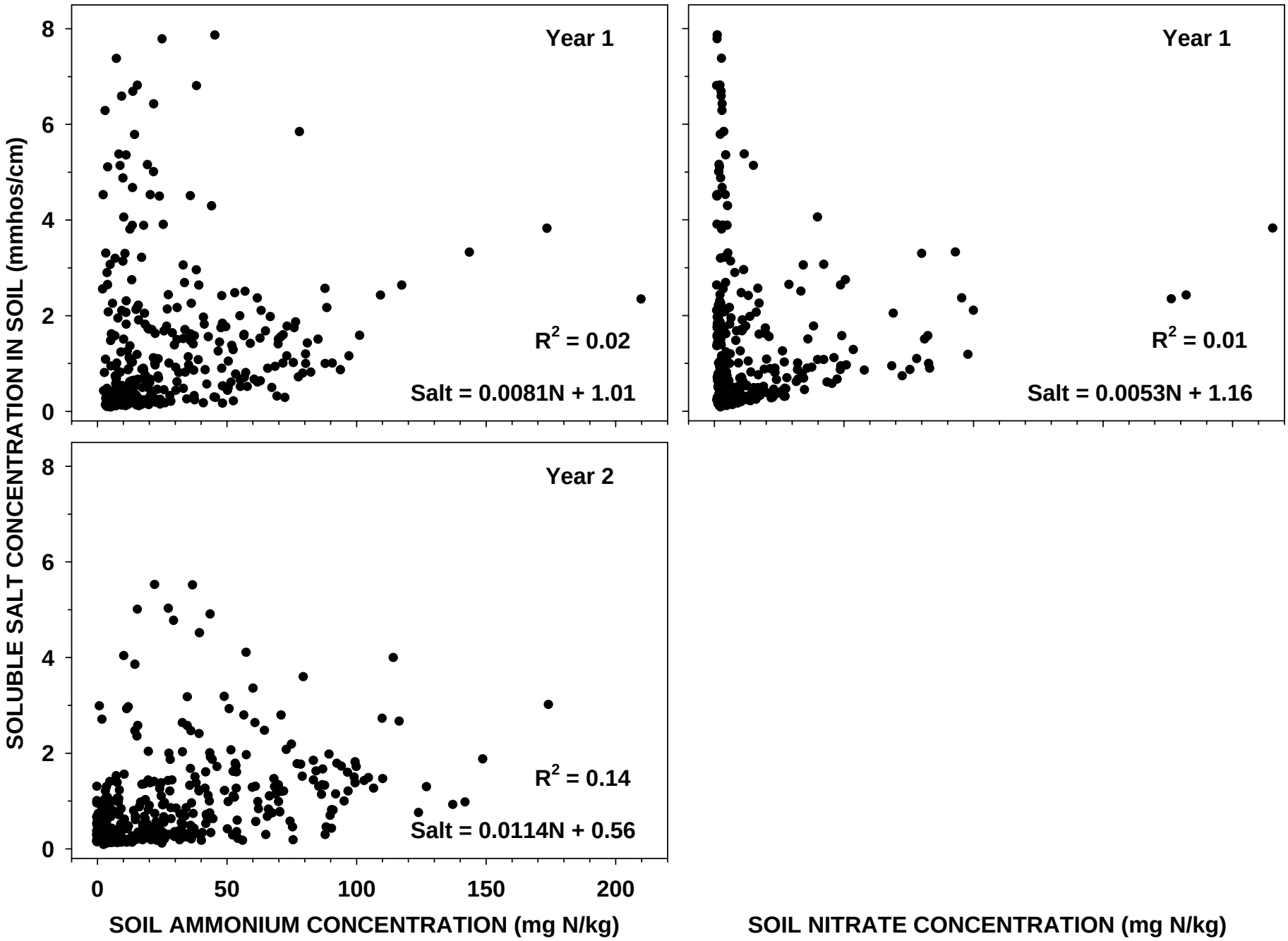

Year 1
R^2 = 0.92
Salt = 0.0026K - 0.07
Year 1
R^2 = 0.93
Salt = 0.0104S + 0.23
Year 2
R^2 = 0.82
Salt = 0.0017K - 0.07
SOLUBLE SALT CONCENTRATION IN SOIL (mmhos/cm)
0
2
4
6
8
0
500
1000
1500
2000
2500
3000
SOIL POTASSIUM CONCENTRATION (mg M3-K/kg)
SOIL SULFUR CONCENTRATION (mg M3-S/kg)

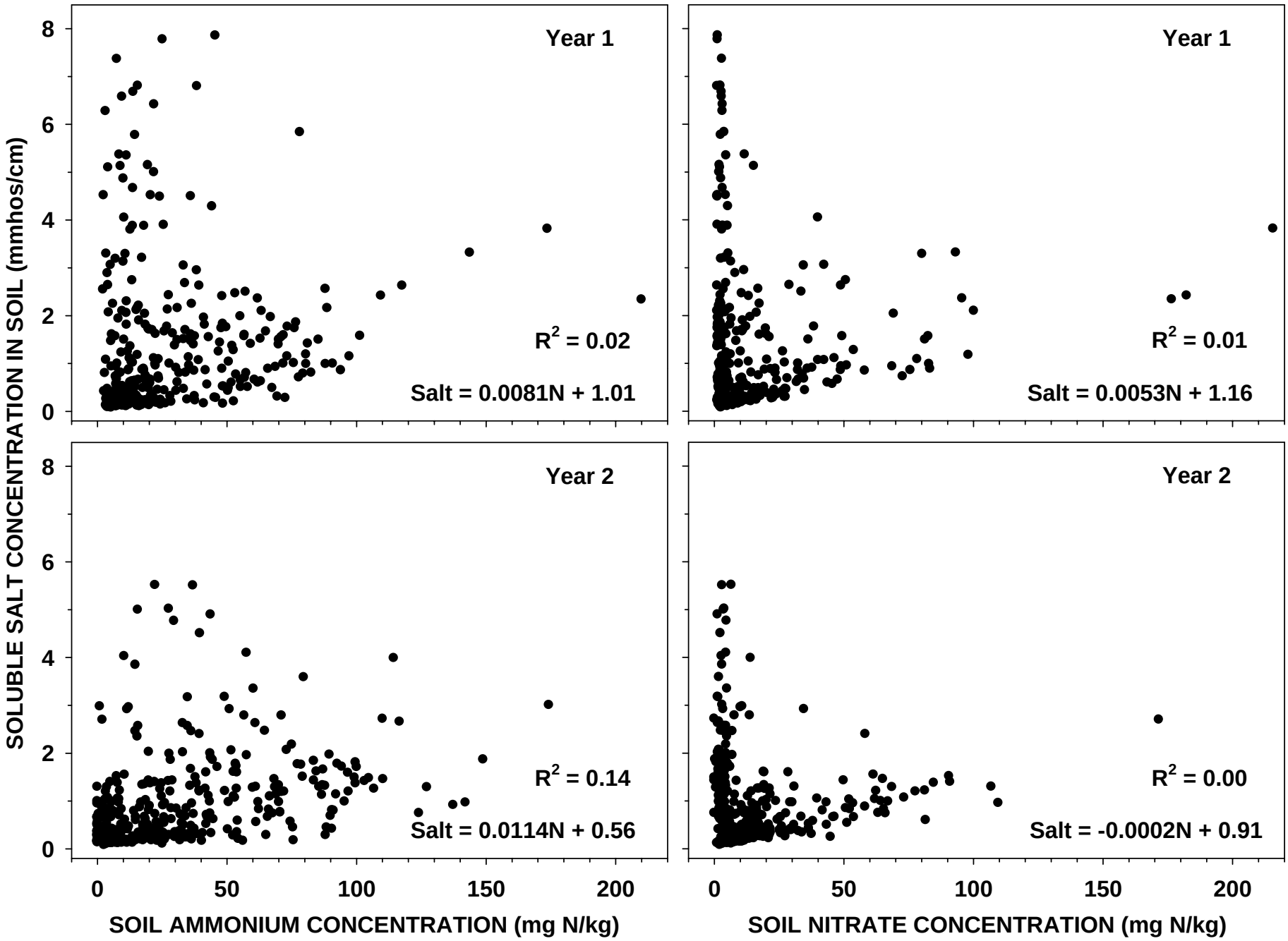

Year 1
R^2 = 0.92
Salt = 0.0026K - 0.07
Year 1
R^2 = 0.93
Salt = 0.0104S + 0.23
Year 2
R^2 = 0.82
Salt = 0.0017K - 0.07
Year 2
R^2 = 0.82
Salt = 0.0077S + 0.22
SOLUBLE SALT CONCENTRATION IN SOIL (mmhos/cm)
0
2
4
6
8
0
500
1000
1500
2000
2500
3000
SOIL POTASSIUM CONCENTRATION (mg M3-K/kg)
0
200
400
600
800
SOIL SULFUR CONCENTRATION (mg M3-S/kg)


SOLUBLE SALT CONCENTRATION IN SOIL (mmhos/cm)
SOIL AMMONIUM CONCENTRATION (mg N/kg)
SOIL NITRATE CONCENTRATION (mg N/kg)


Year 1
R^2 = 0.02
Salt = 0.0081N + 1.01
SOLUBLE SALT CONCENTRATION IN SOIL (mmhos/cm)
0
2
4
6
8
SOIL AMMONIUM CONCENTRATION (mg N/kg)
SOIL NITRATE CONCENTRATION (mg N/kg)


Year 1
R^2 = 0.02
Salt = 0.0081N + 1.01
Year 2
R^2 = 0.14
Salt = 0.0114N + 0.56
SOLUBLE SALT CONCENTRATION IN SOIL (mmhos/cm)
0
2
4
6
8
0
50
100
150
200
SOIL AMMONIUM CONCENTRATION (mg N/kg)
SOIL NITRATE CONCENTRATION (mg N/kg)


Year 1
R^2 = 0.02
Salt = 0.0081N + 1.01
Year 1
R^2 = 0.01
Salt = 0.0053N + 1.16
Year 2
R^2 = 0.14
Salt = 0.0114N + 0.56
SOLUBLE SALT CONCENTRATION IN SOIL (mmhos/cm)
0
2
4
6
8
0
50
100
150
200
SOIL AMMONIUM CONCENTRATION (mg N/kg)
SOIL NITRATE CONCENTRATION (mg N/kg)


Year 1
R^2 = 0.02
Salt = 0.0081N + 1.01
Year 1
R^2 = 0.01
Salt = 0.0053N + 1.16
Year 2
R^2 = 0.14
Salt = 0.0114N + 0.56
Year 2
R^2 = 0.00
Salt = -0.0002N + 0.91
SOLUBLE SALT CONCENTRATION IN SOIL (mmhos/cm)
SOIL AMMONIUM CONCENTRATION (mg N/kg)
SOIL NITRATE CONCENTRATION (mg N/kg)
0
2
4
6
8
0
50
100
150
200

Summary and Conclusions

- All spray-on covers didn't provide a benefit and were sometimes worse
- Nutrients are being lost from poultry piles
- The nutrient being lost in the greatest amounts (about 8 times) is potassium
- Potassium concentrations are the main contributor to soluble salts concentrations
- Poly covers provided no benefit for N losses
- Nitrogen is lost from piles both as leachate (edges) and probably as ammonia gas

Summary and Conclusions

- Nitrogen is being lost from litter piles to the soil and because of limited to no plant growth is most likely being lost to the environment
- These amounts should be kept in perspective
- Piled litter has less potential for nutrient losses than litter spread at the “wrong time”
- Establishment of growing plants in these areas would reduce these potential losses
- Current regulations should be followed!!!

WMP = WORST MANAGEMENT PRACTICE