Lime and Sulfur trials in Texas

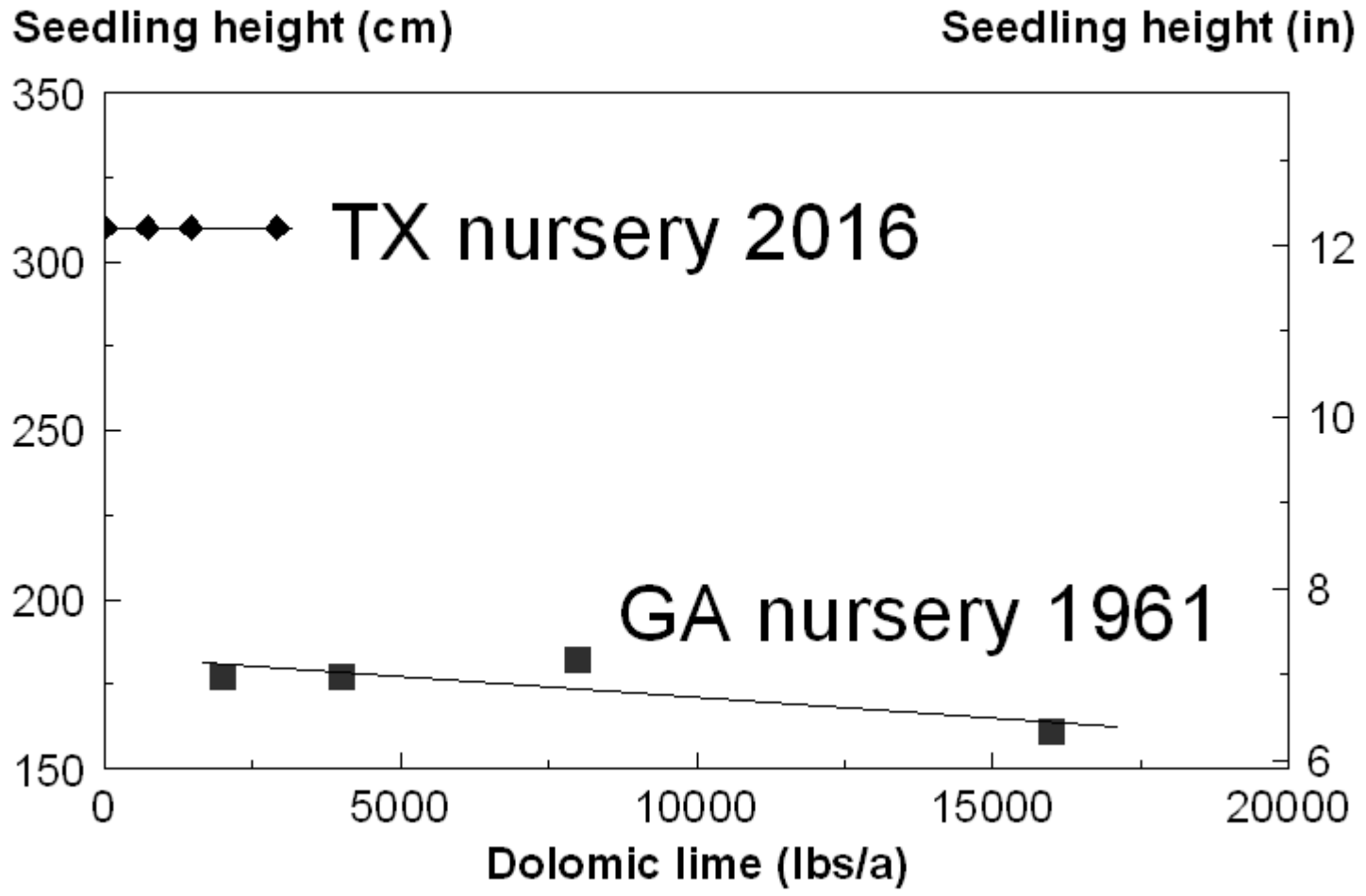
David South, Gene Bickerstaff and Ryan Nadel

Two liming studies were conducted in Georgia in 1961. 1, 2,4,8 tons/acre

The authors suggested that soil reaction in the South should be pH 5.5 to 6.5 (Steinbeck et al 1966). Since that time, others have said this range is optimum. Liming trials have not been published for over 4 decades in the South.

Since 1966, some continue to suggest lime be applied to seedbeds when soil is below pH 5.5

pH range	**Author**	**Reference**
5.5-6.5	Klaus Steinbeck	Steinbeck et al. 1966
5.5-6.5	F.M. Solan	Solan et al. 1979
5.5-6.5	Chet Youngberg	Youngberg 1984
5.5-6.5	Tom Landis	Landis 1990
5.5-6.5	Santiago Bueno	Bueno et al. 2012


Seedling height (cm)
Seedling height (in)
350
300
250
200
150
12
10
8
6
0
5000
10000
15000
20000
TX nursery 2016
GA nursery 1961
Dolomic lime (lbs/a)

Two pH trials in 2016

Four rates of sulfur (replicated 4 times)

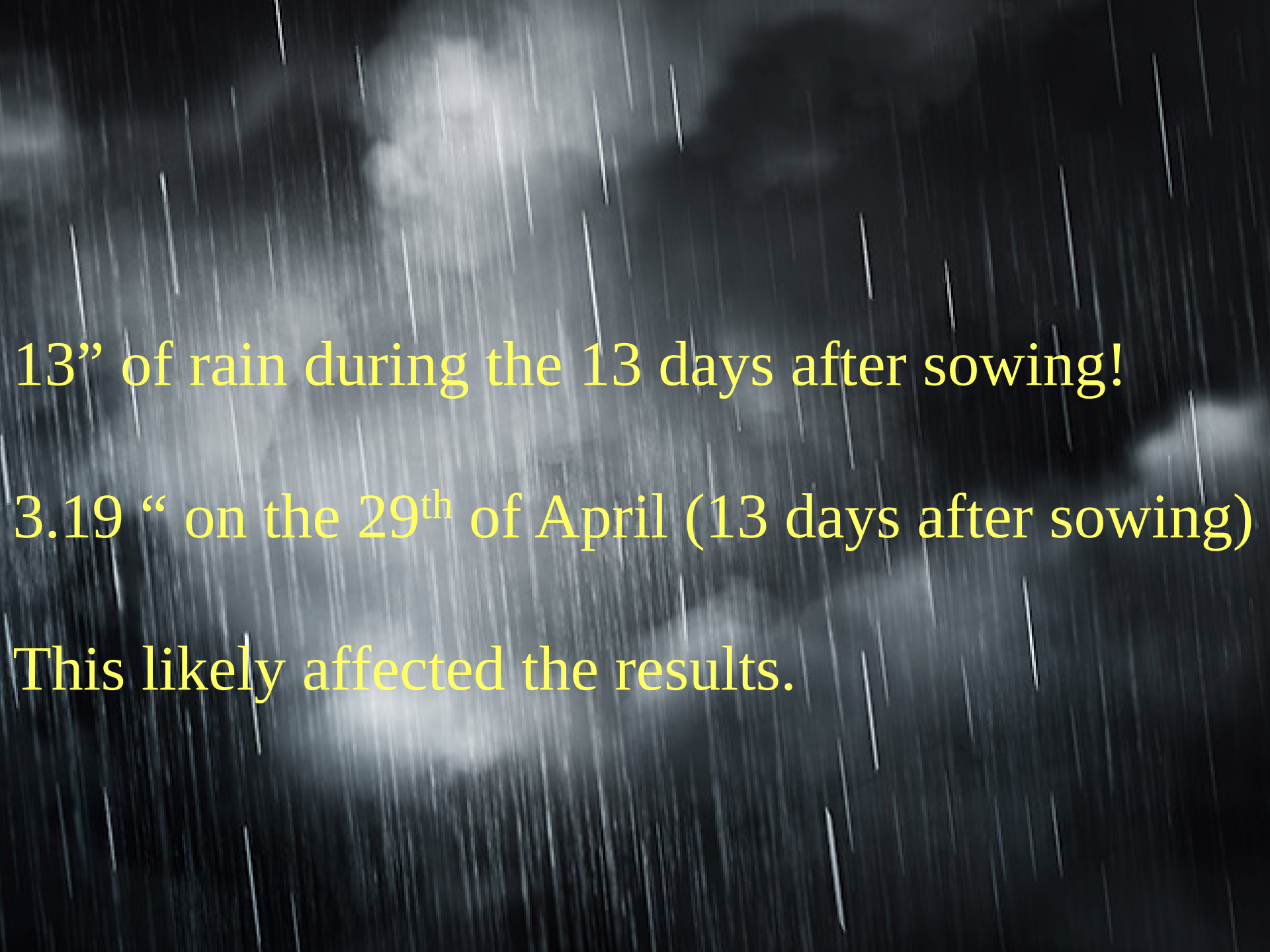
0, 726, 1452, 2178 lbs/a

Four rates of dolomitic lime (replicated 4 times)

0, 726, 1452, 2904 lbs/a

Treatments applied to 20’ long plots on April 9th

Seed sown 1 week later; Operational fertilizers applied. C.E.C. = 1.5 meq/100 g



13” of rain during the 13 days after sowing!

3.19 “ on the 29th of April (13 days after sowing)

This likely affected the results.

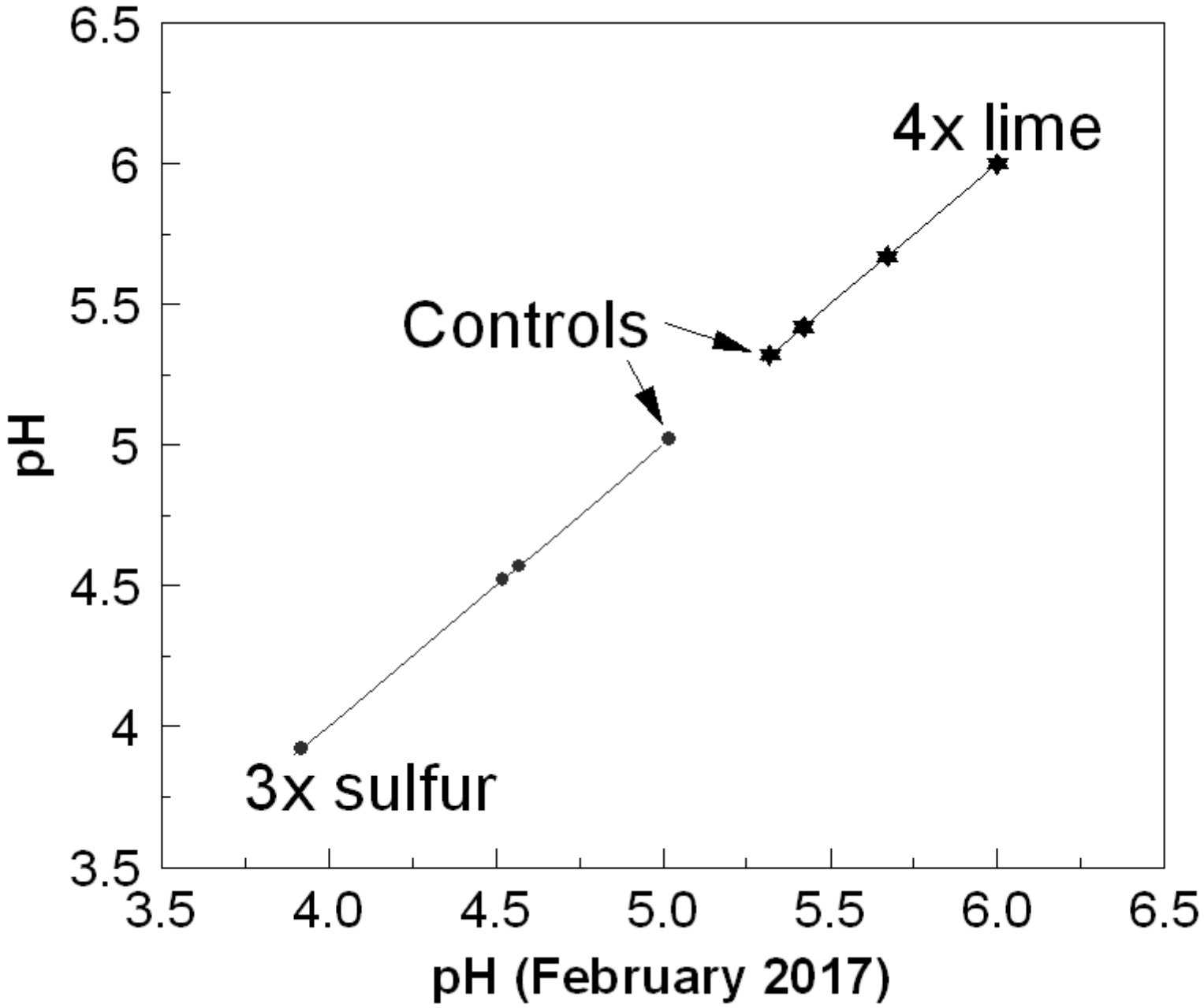
Lime trial – July 5, 2016 – no visible treatment effects

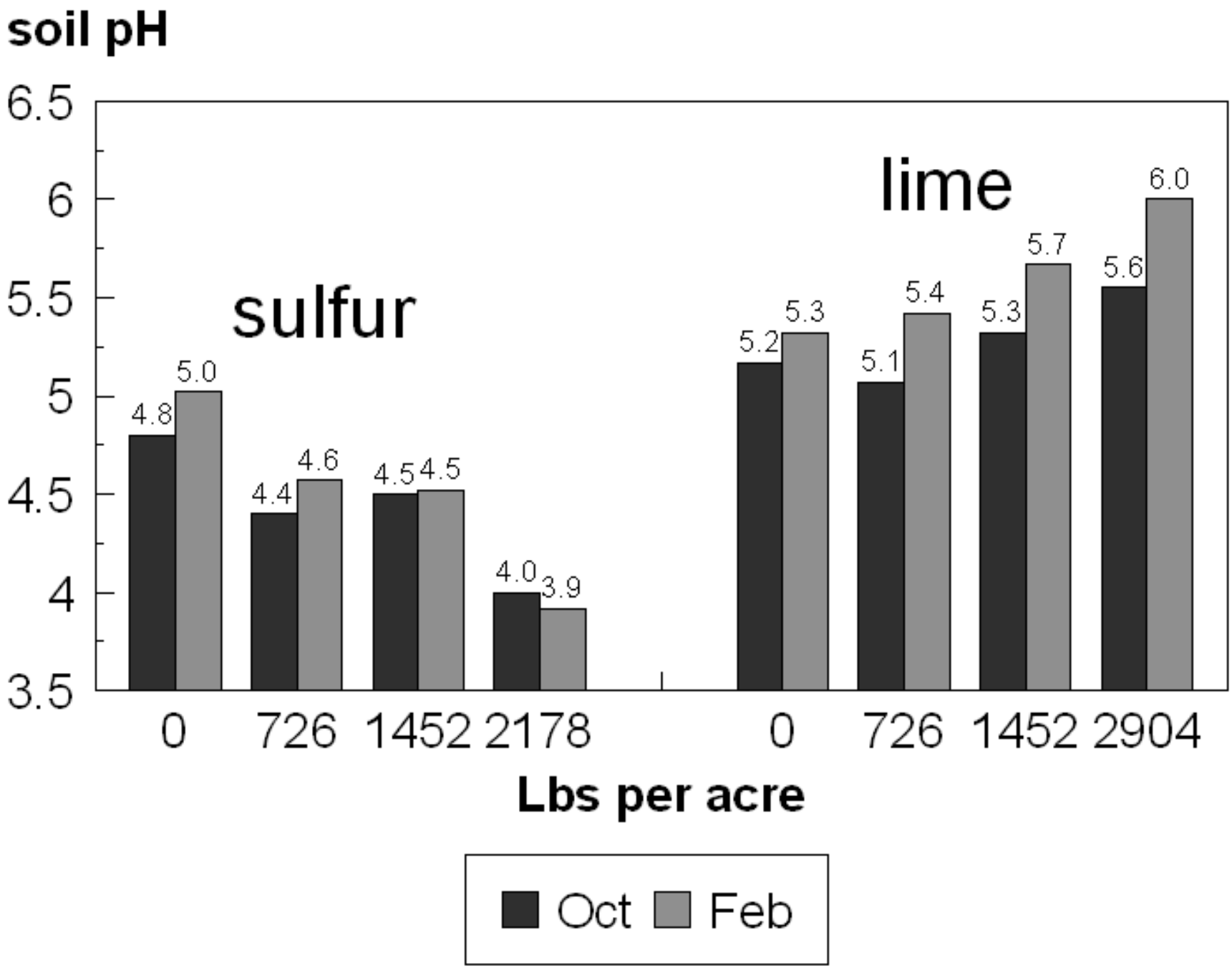
to by Gene Bickerstaff

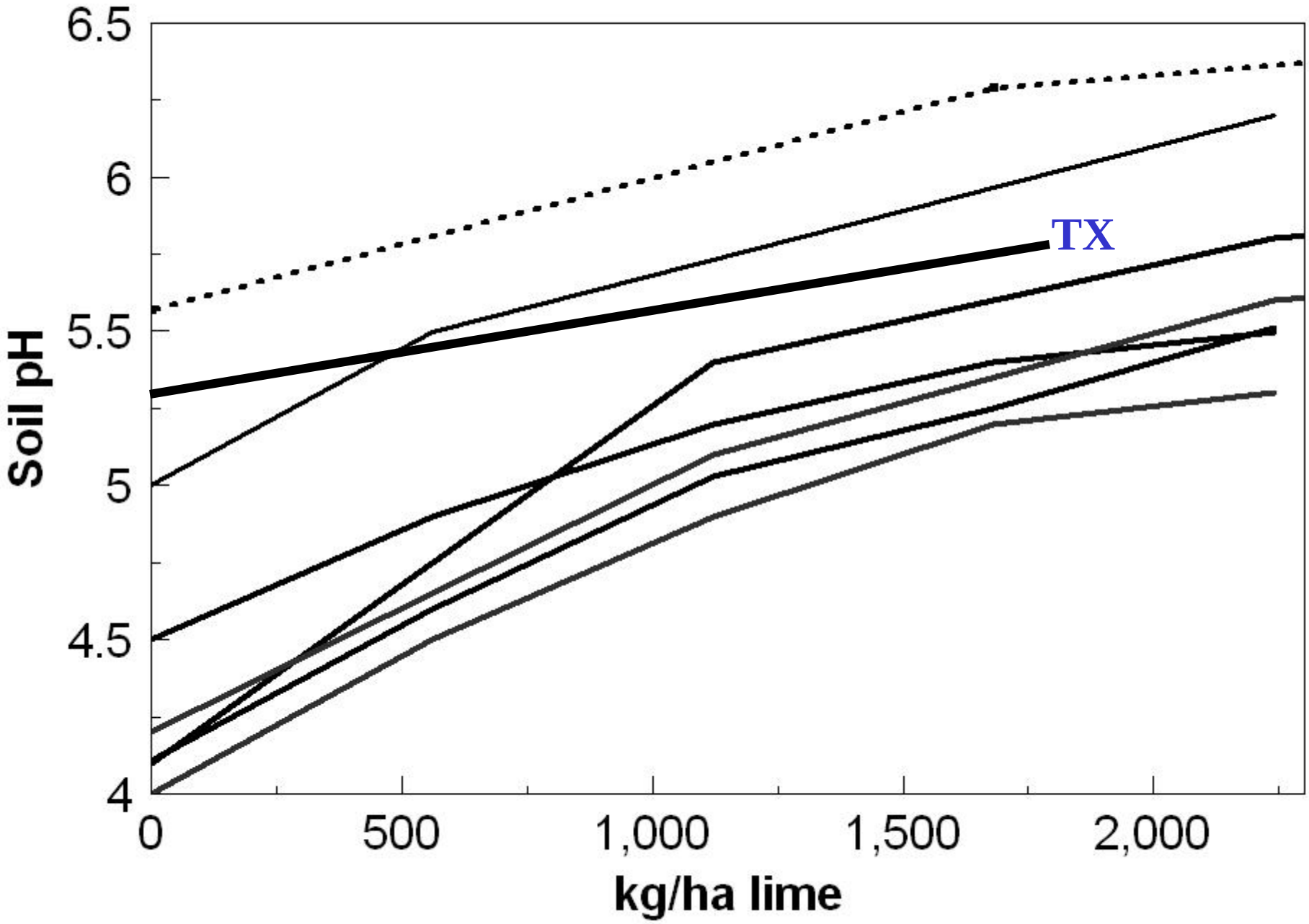
Sulfur trial – July 5, 2016 – no visible effects

Photo by Gene Bickerstaff


Sulfur trial
Lime trial
Seedlings lifted Feb 7, 2017
Photo by Gene Bickerstaff


6.5
6
5.5
5
4.5
4
3.5
pH
4x lime
Controls
3x sulfur
3.5
4.0
4.5
5.0
5.5
6.0
6.5
pH (February 2017)


soil pH
6.5
6
5.5
5
4.5
4
3.5
sulfur
lime
4.8
5.0
4.4
4.6
4.5
4.5
4.0
3.9
5.2
5.3
5.1
5.4
5.3
5.7
5.6
6.0
0
726
1452
2178
0
726
1452
2904
Lbs per acre
Oct
Feb


6.5
6
5.5
5
4.5
4
Soil pH
0
500
1,000
1,500
2,000
kg/ha lime
TX

The sulfur treatments did not significantly affect seedling morphology ($p > 0.15$).
One plot was lowered to pH 3.5 or 3.6.

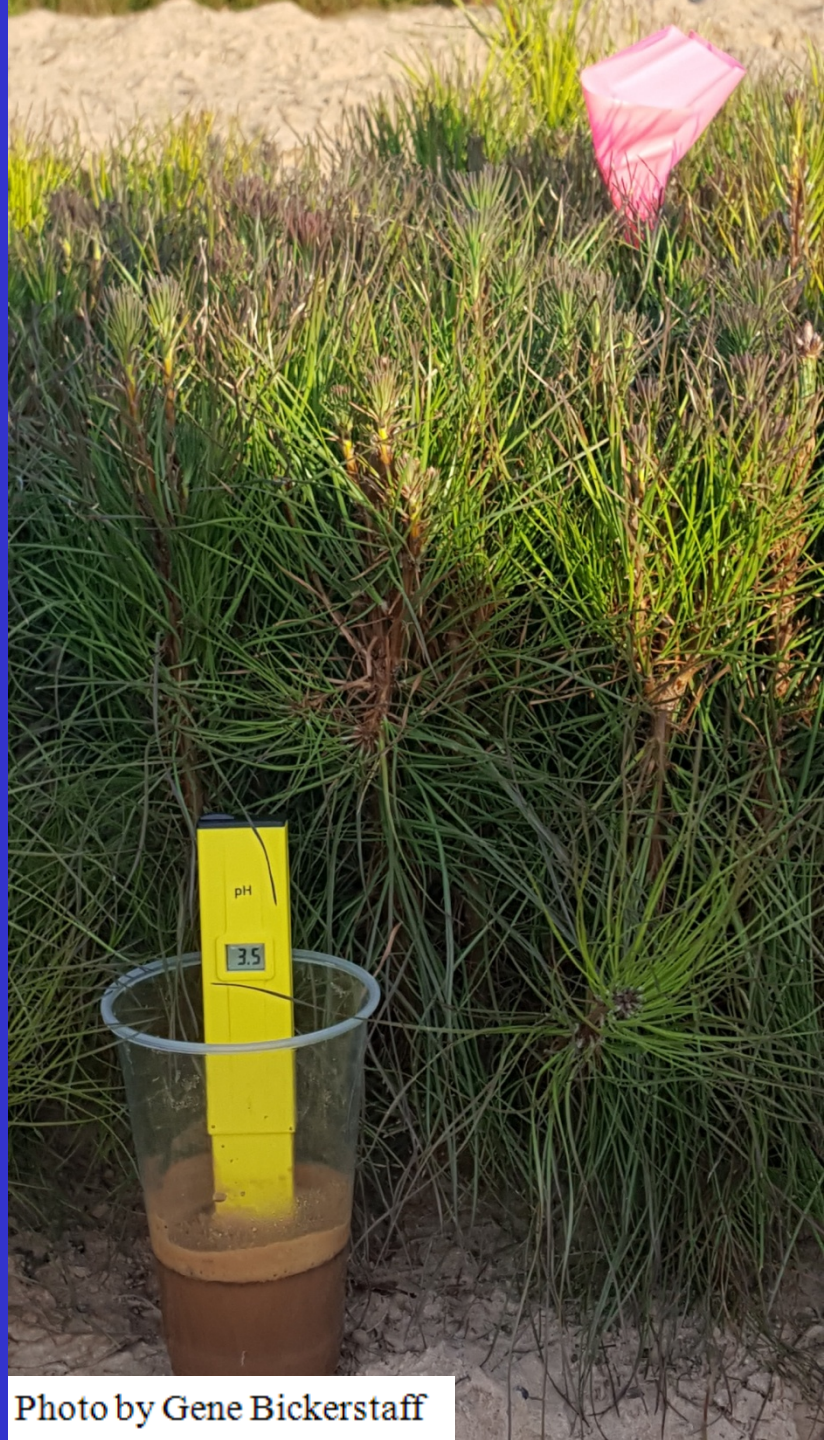


Photo by Gene Bickerstaff

The sulfur treatments did not significantly affect seedling morphology.

Seedling from the pH 3.6 plot were

Ht = 31.8 cm
RCD = 8.3 mm
Shoot mass = 9.4 g
Root mass = 2.6 g
Root weight ratio = 0.22

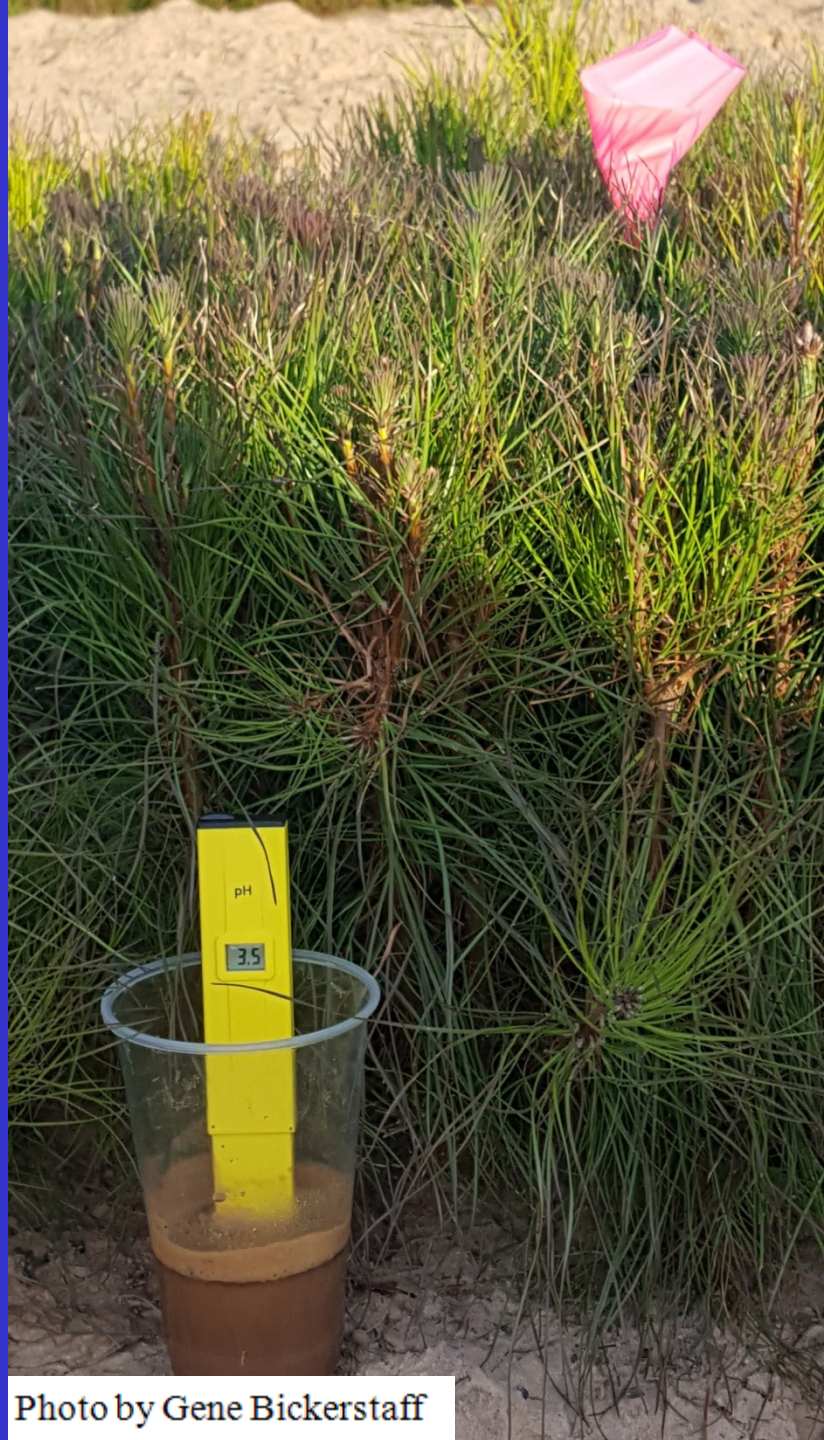
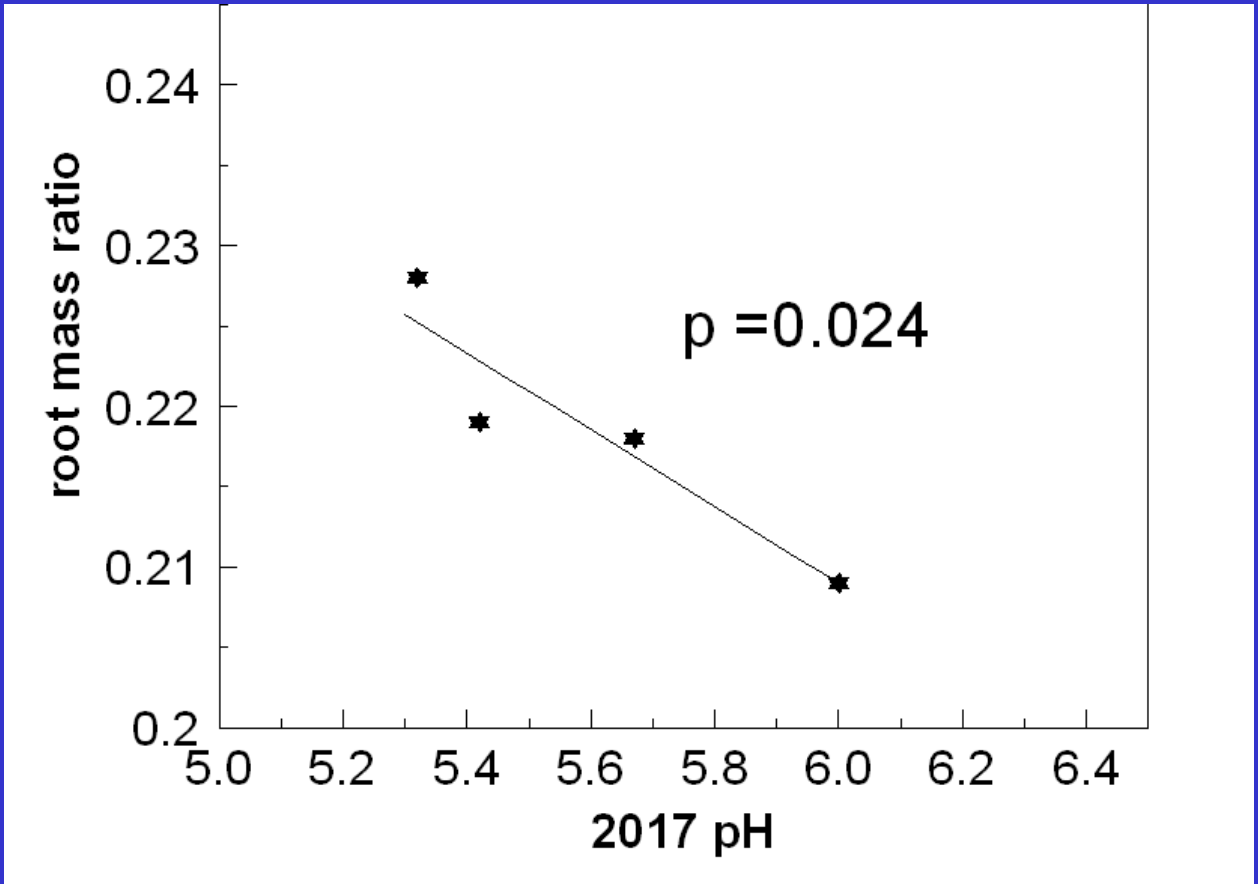


Photo by Gene Bickerstaff

The lime treatments did not affect root mass or shoot mass but did affect the balance between roots and shoots.



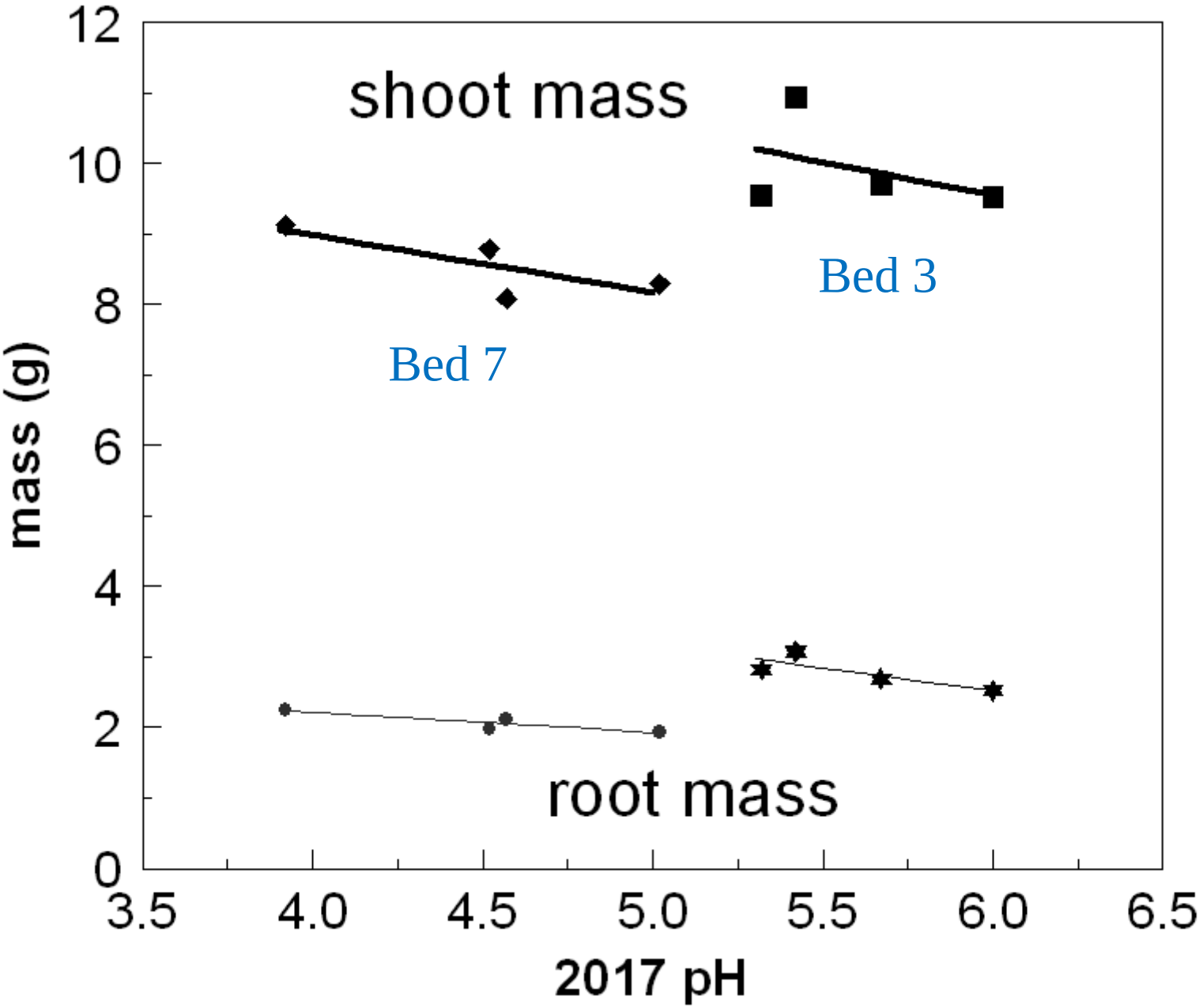
Does not agree with Helm and Kuser 1991. Northern Journal of Applied Forestry. 8(2): 63-68. and Marx 1990. Forest Science

Plot location did affect seedling size

Photo by Gene Bickerstaff

Replication affected RCD in the sulfur trial.

In the lime trial, replication affected height, RCD and mass of roots and shoot.


shoot mass
Bed 3
Bed 7
root mass
mass (g)
2017 pH
0
2
4
6
8
10
12
3.5
4.0
4.5
5.0
5.5
6.0
6.5

The good growth of loblolly pine at pH 3.9
supports the statement by Chuck Davey.

“Even at pH 4, hydrogen ions are not toxic.”

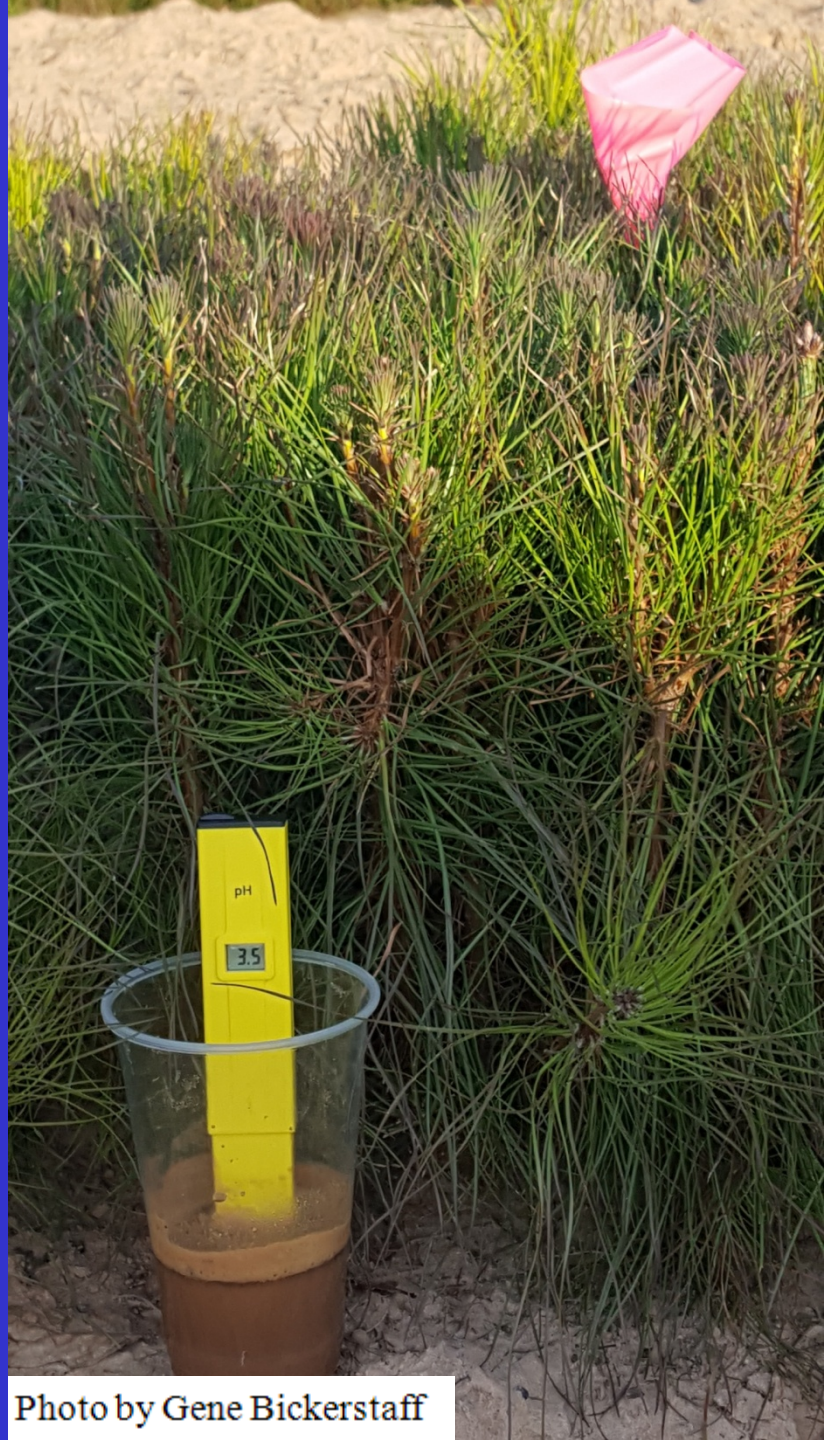


Photo by Gene Bickerstaff

Lime and sulfur applications affect soil nutrients

Lab Number : 46644

Test	Method	Results
Soil pH	1:1	5.4
Buffer pH	BPH	6.88
Phosphorus (P)	M3	
Potassium (K)	M3	
Calcium (Ca)	M3	
Magnesium (Mg)	M3	
Sulfur (S)	M3	
Boron (B)	M3	
Copper (Cu)	M3	
Iron (Fe)	M3	
Manganese (Mn)	M3	
Zinc (Zn)	M3	
Sodium (Na)	M3	
Soluble Salts		
Organic Matter	LOI	
Nitrate Nitrogen		

As expected, sulfur applications increased sulfur and liming increased calcium and magnesium.

3x sulfur added 15 ppm S

4x lime added 46 ppm Ca and 12 ppm Mg

Sulfur applications affect soil nutrients

3X sulfur applications REDUCED the level of cations.

K by 7 ppm
Ca by 39 ppm
Mg by 5 ppm
Mn by 7 ppm
Zn by 0.2 ppm

Lime applications do affect soil nutrients

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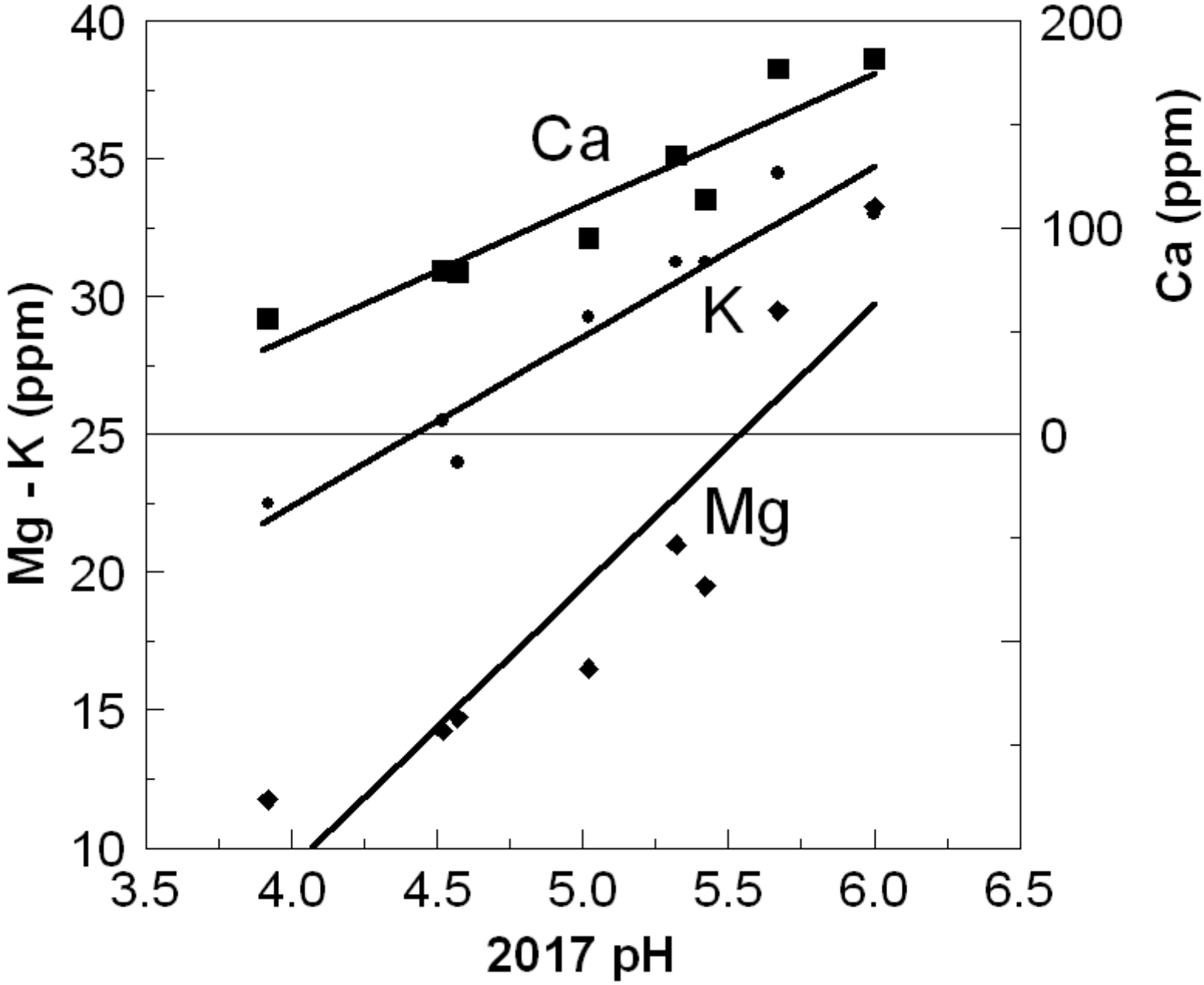
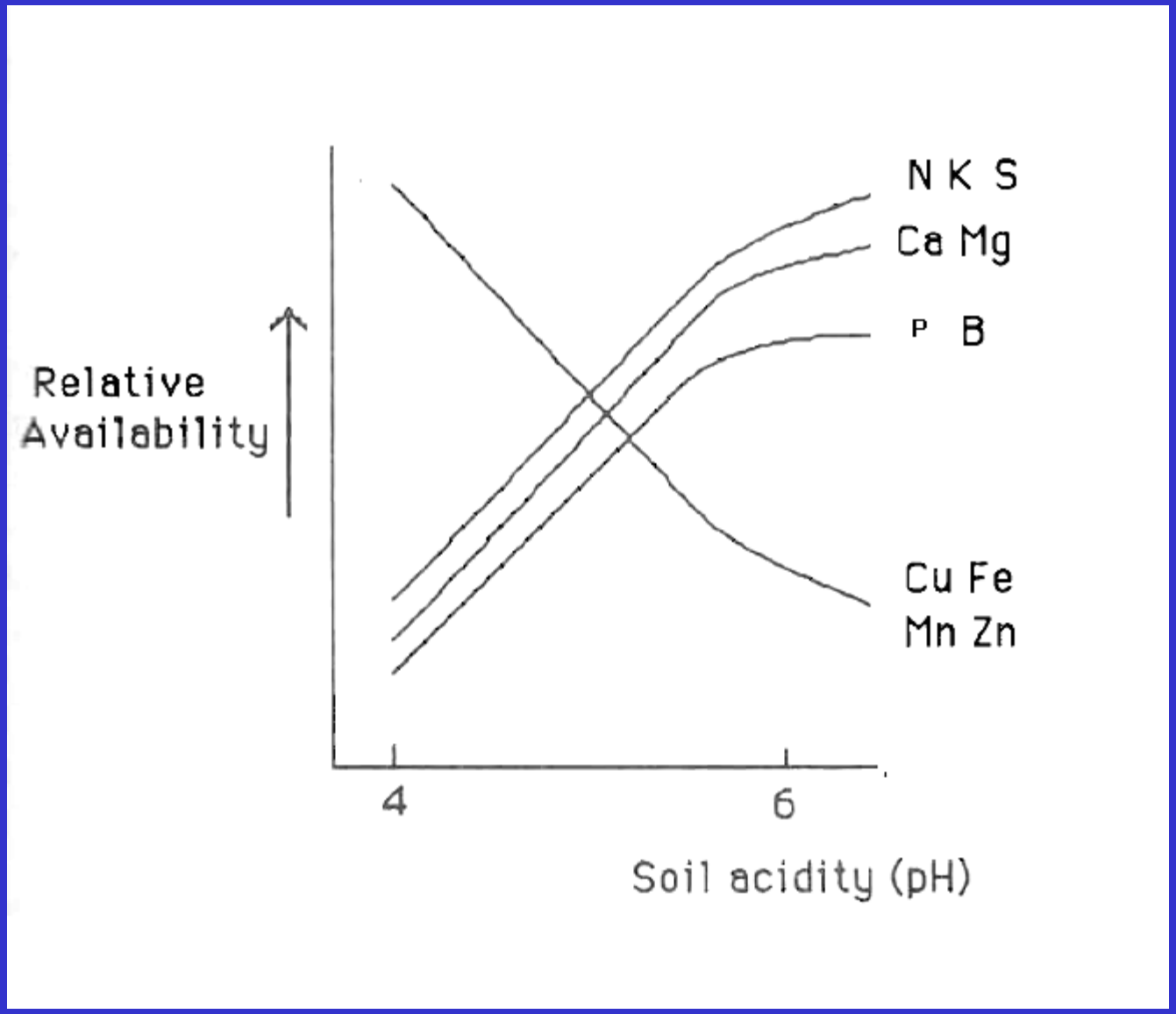
Phosphorus (P)	M3	
Potassium (K)	M3	
Calcium (Ca)	M3	
Magnesium (Mg)	M3	
Sulfur (S)	M3	
Boron (B)	M3	
Copper (Cu)	M3	
Iron (Fe)	M3	
Manganese (Mn)	M3	
Zinc (Zn)	M3	
Sodium (Na)	M3	
Soluble Salts		
Organic Matter	LOI	
Nitrate Nitrogen		

4X lime applications INCREASED two micronutrients.

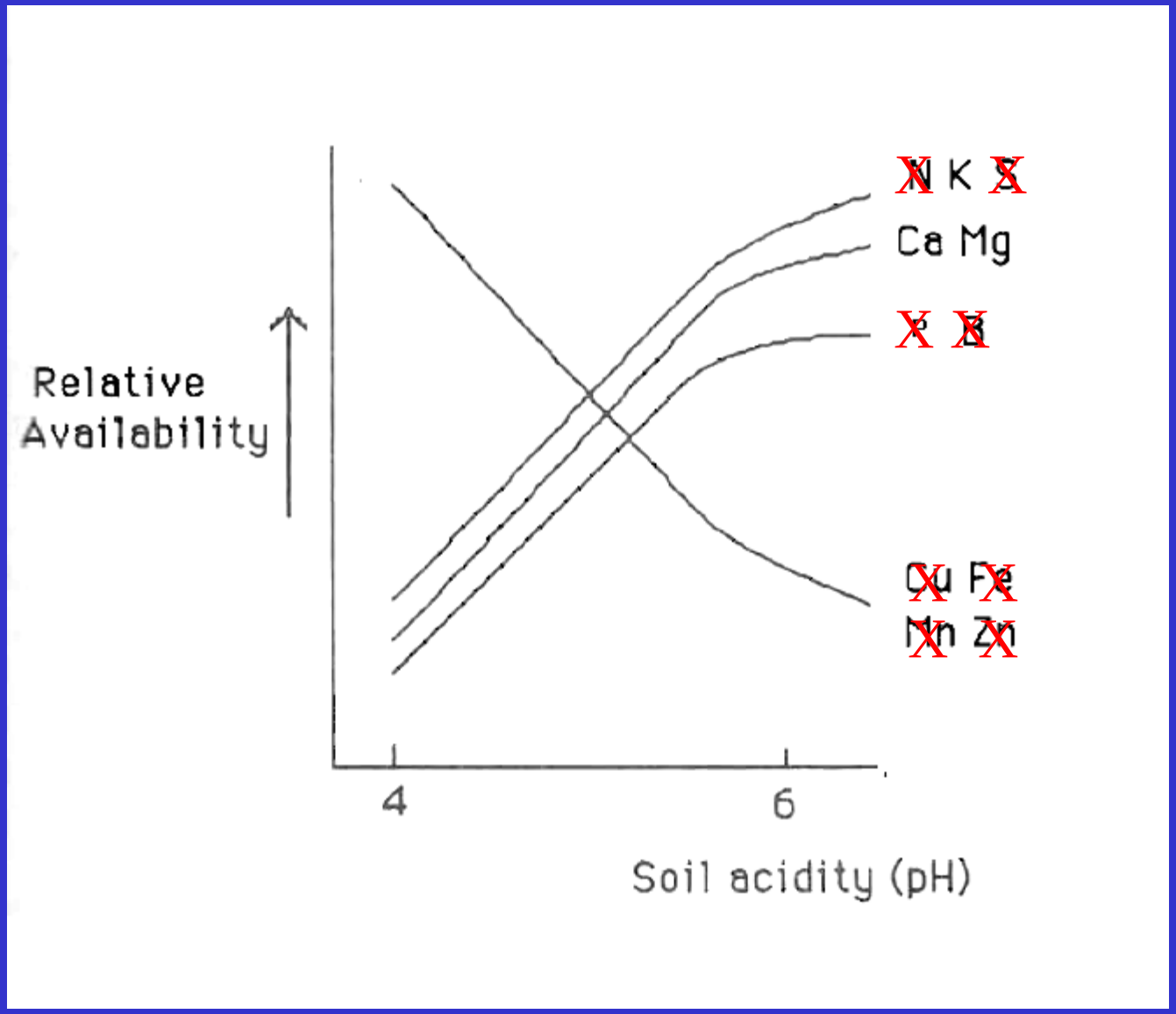
Cu by 0.05 ppm
Mn by 6 ppm

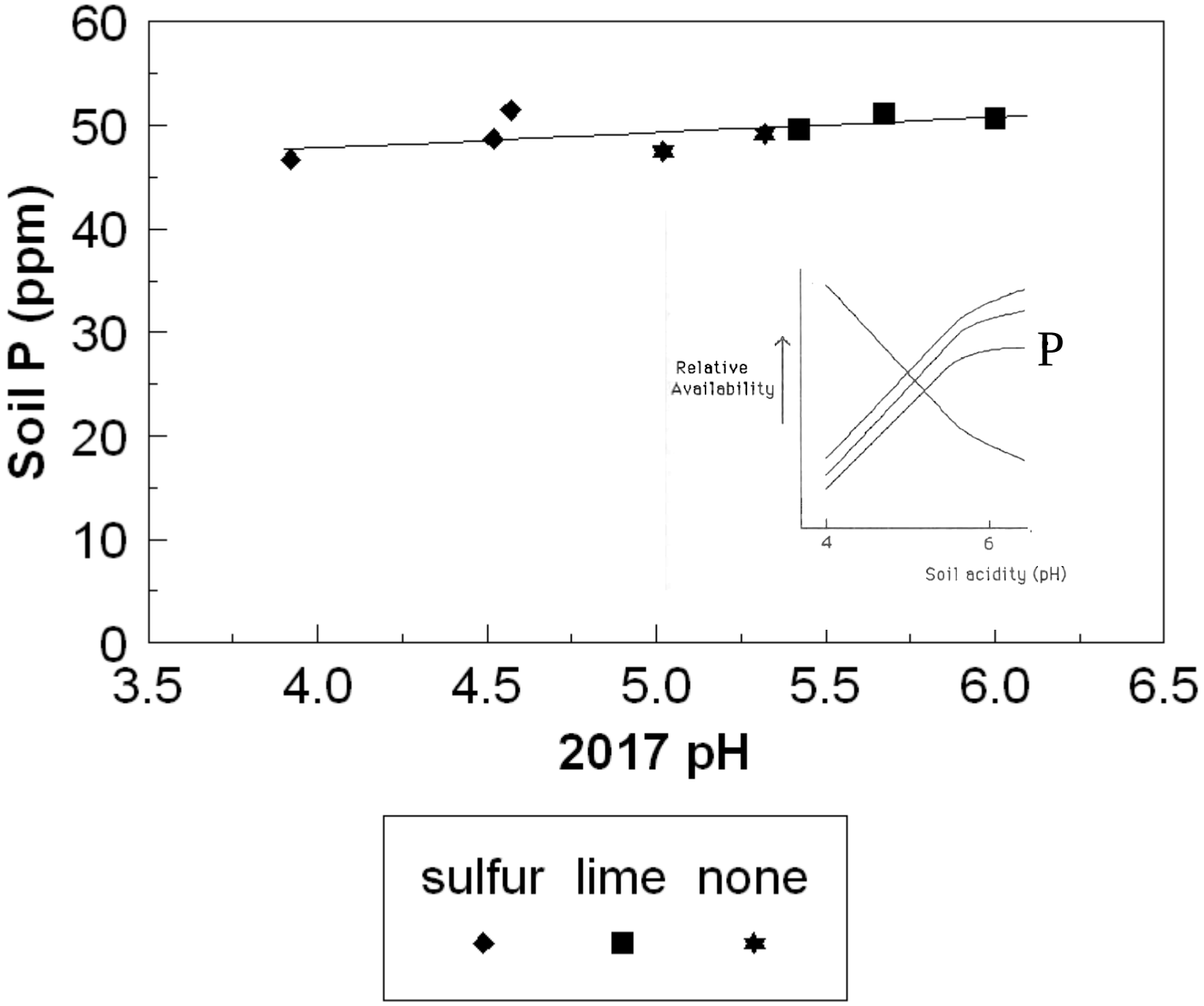

40
35
30
25
20
15
10
Mg - K (ppm)
200
100
0
Ca (ppm)
Ca
K
Mg
3.5
4.0
4.5
5.0
5.5
6.0
6.5
2017 pH

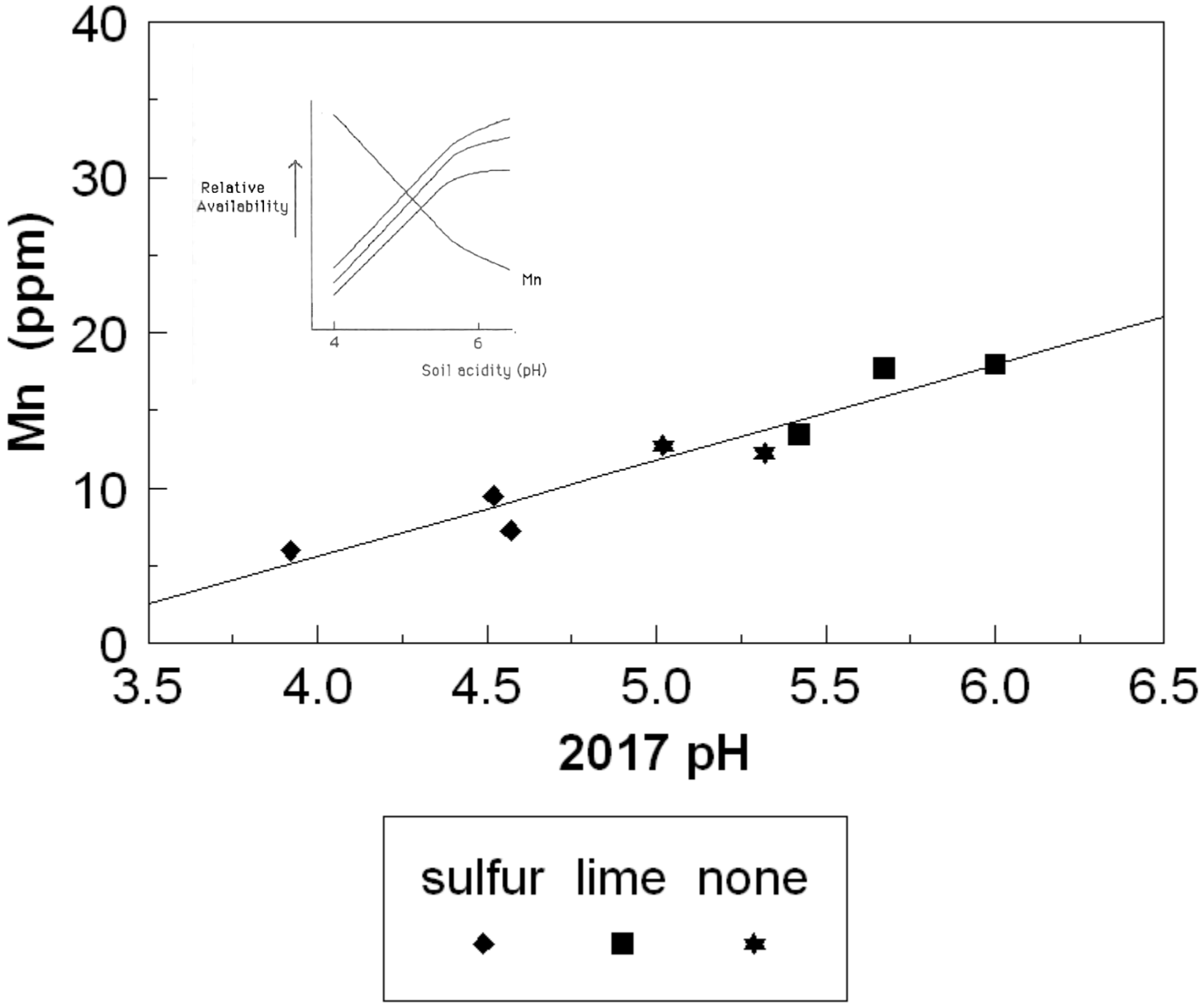
Do our results agree with this chart?



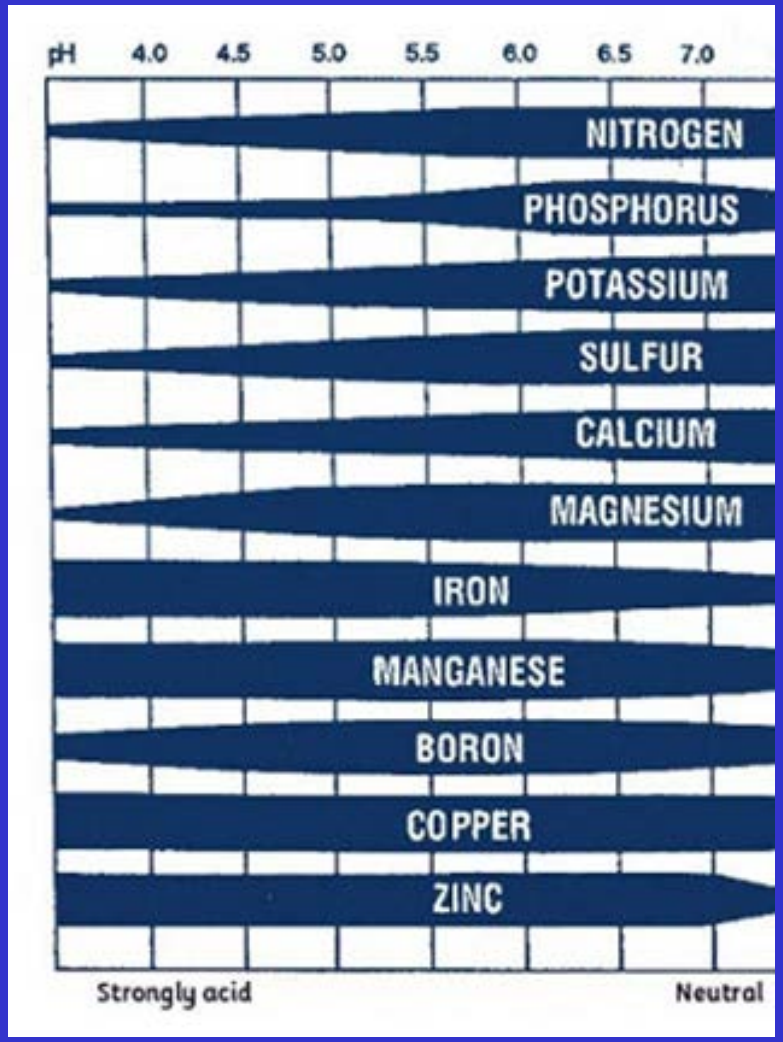
Do our results agree with this chart?




60
50
40
30
20
10
0
Soil P (ppm)
3.5
4.0
4.5
5.0
5.5
6.0
6.5
2017 pH
Relative Availability
P
4
6
Soil acidity (pH)
sulfur
lime
none


Mn (ppm)
40
30
20
10
0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
2017 pH
Relative Availability
Mn
4
6
Soil acidity (pH)
sulfur
lime
none

Do our soil tests agree with the textbook theory regarding soil pH and nutrient *availability*?



Our correlations (pH vs soil)

???

No change X

Increase with > pH

No change X

Increase with > pH

Increase with > pH

No change

Increase with >pH X

Low no change X

No change

Increase with >pH X

N = 32…. N = 20 for S, Ca, Mg

Sulfur and lime applications affect foliar nutrients

3X sulfur applications

increased S by 300 ppm
reduced B by 3 ppm

4X lime reduced

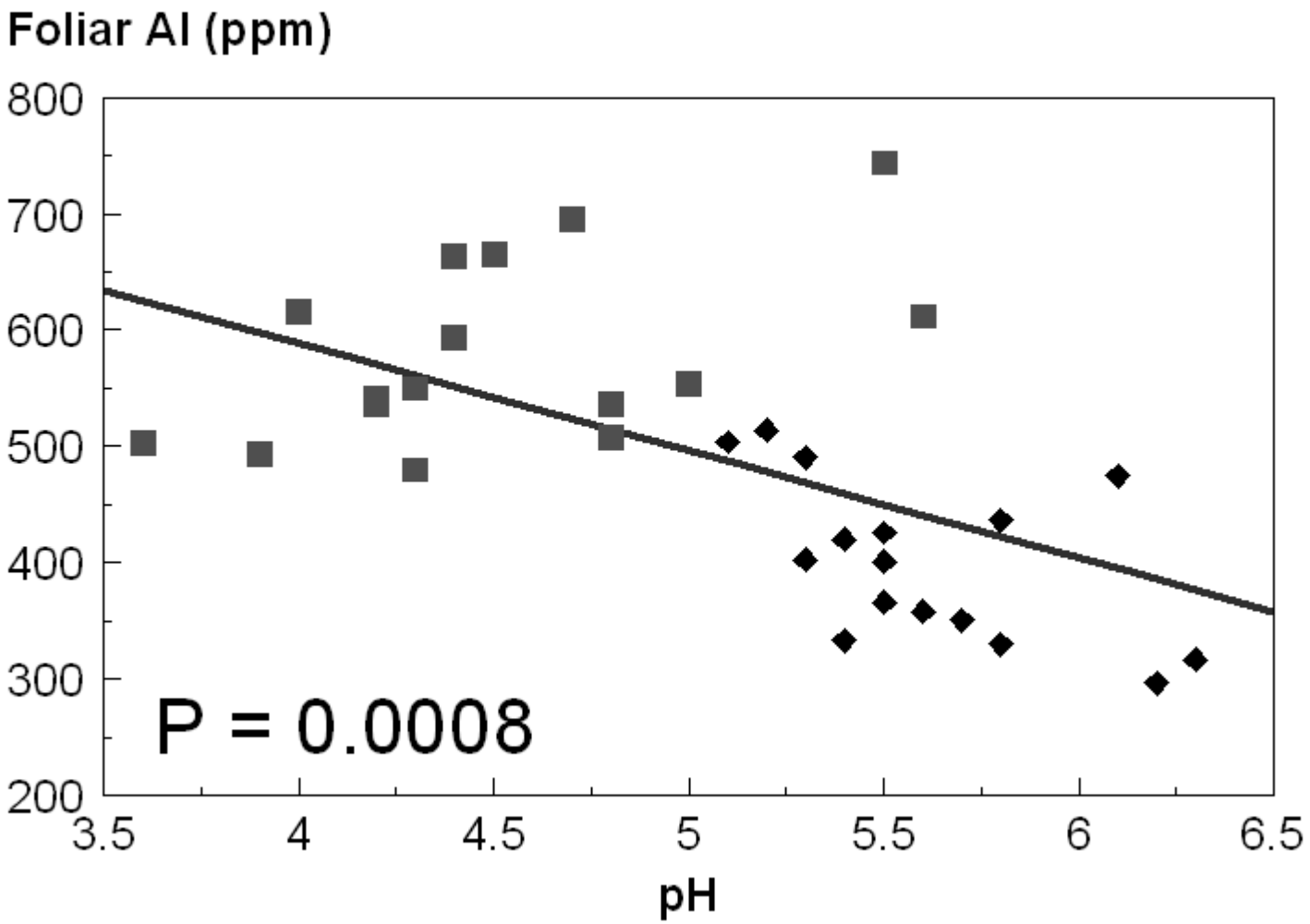
Mn by 259 ppm
Al by 104 ppm

Does soil pH affect foliar nutrition? Yes…..

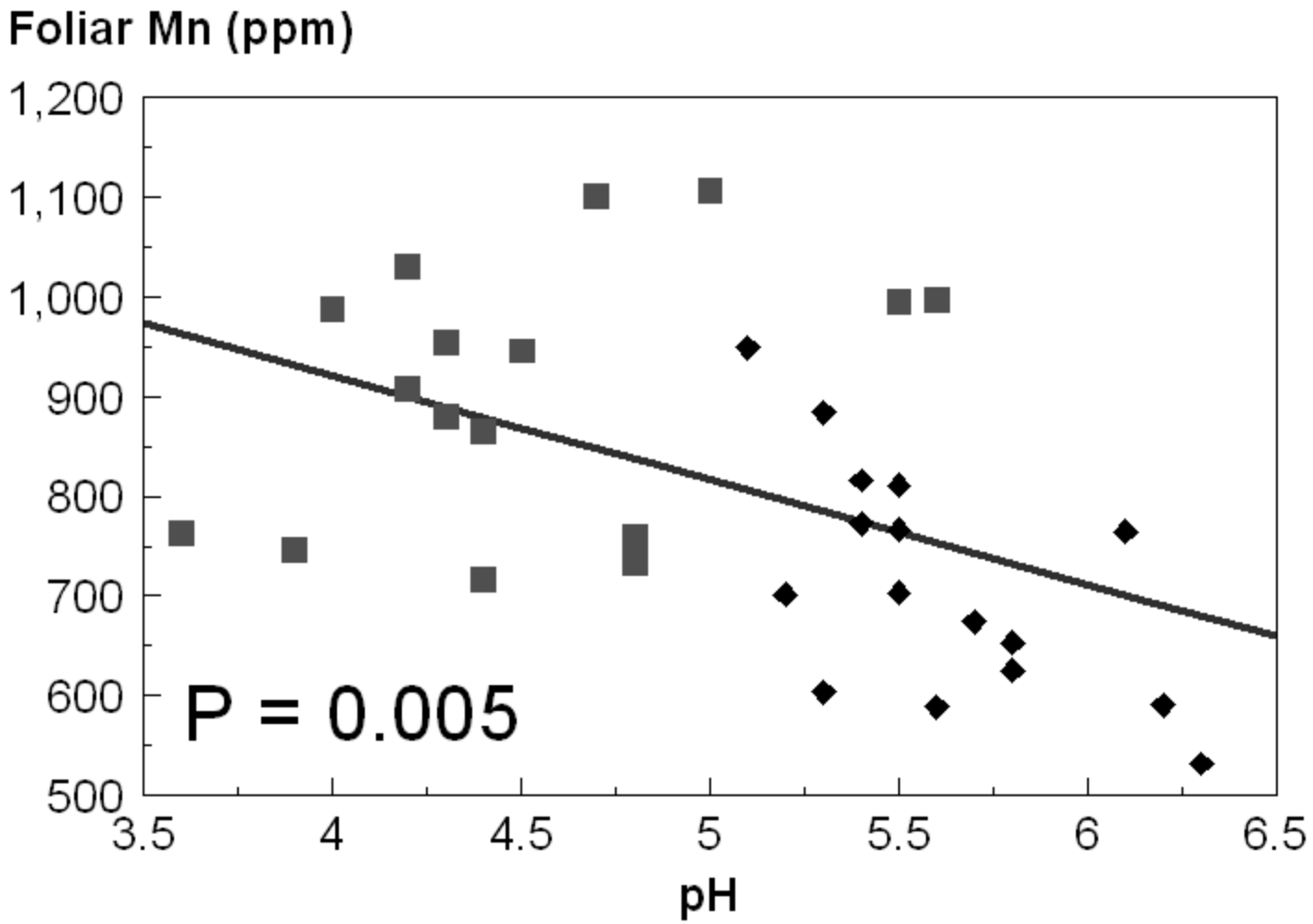
Photo by Gene Bickerstaff

Correlations between soil pH and foliar nutrients for study plots.

Element	Plots	Mean	slope	R^2	P > |t|
Aluminum ppm	32	491	-92	0.319	0.001
Manganese ppm	32	810	-105	0.232	0.005
Zinc ppm	32	42	3	0.186	0.014
Nitrogen %	32	1.17	-0.06	0.134	0.039
Magnesium %	20	0.10	0.006	0.194	0.052
Phosphorus %	32	0.14	-0.008	0.117	0.055
Boron ppm	32	19	-0.95	0.069	0.145
Copper ppm	32	11	-0.88	0.050	0.215
Iron ppm	32	175	-13	0.036	0.295
Potassium %	32	0.74	-0.014	0.019	0.453
Sulfur %	20	0.0009	-0.003	0.010	0.667
Sodium %	32	0.03	-0.09	0.003	0.743
Calcium %	20	0.39	0.0011	0.000	0.939



Agrees with Helm and Kuser. 1991. Northern Journal of Applied Forestry. 8(2): 63-68.



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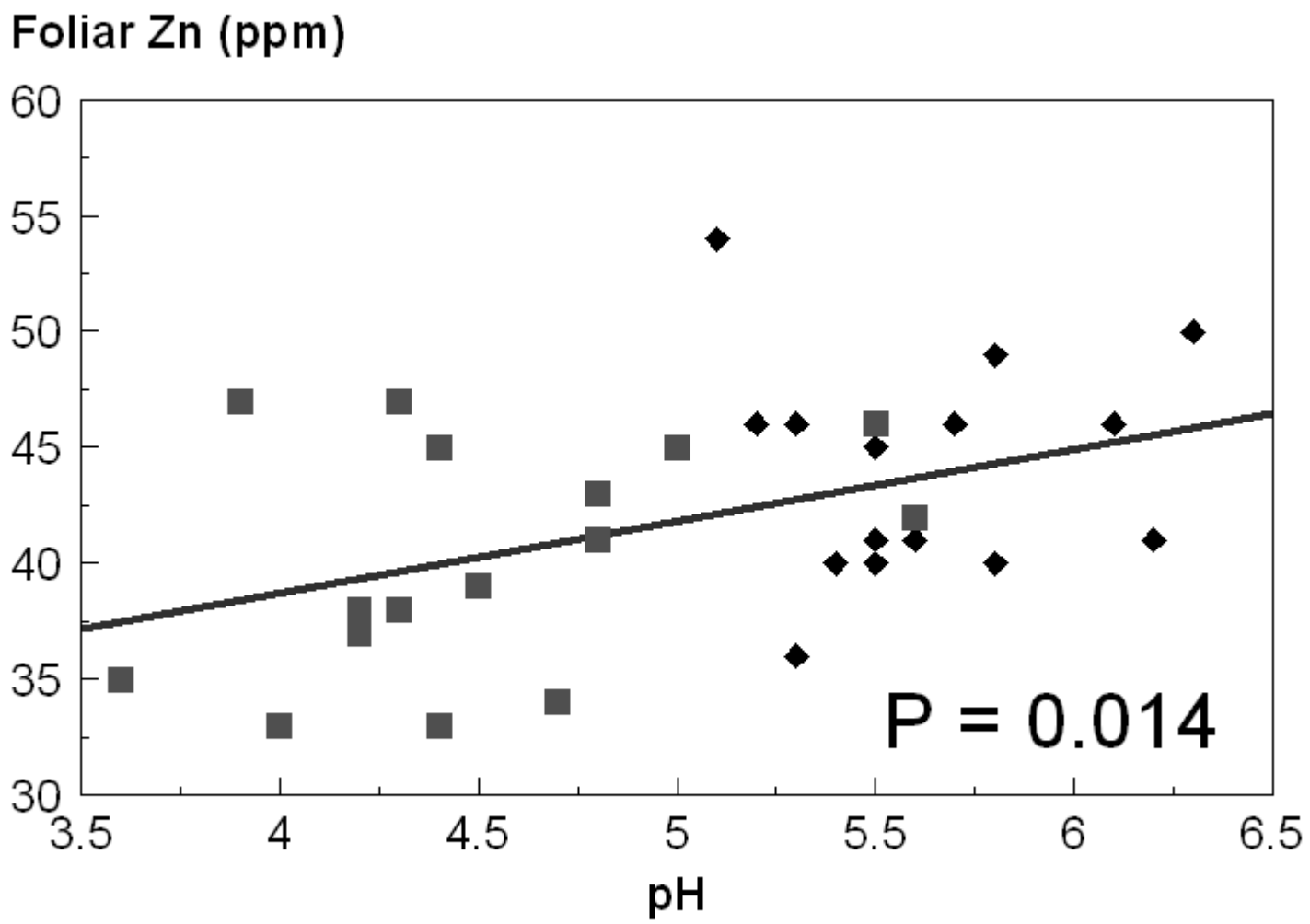
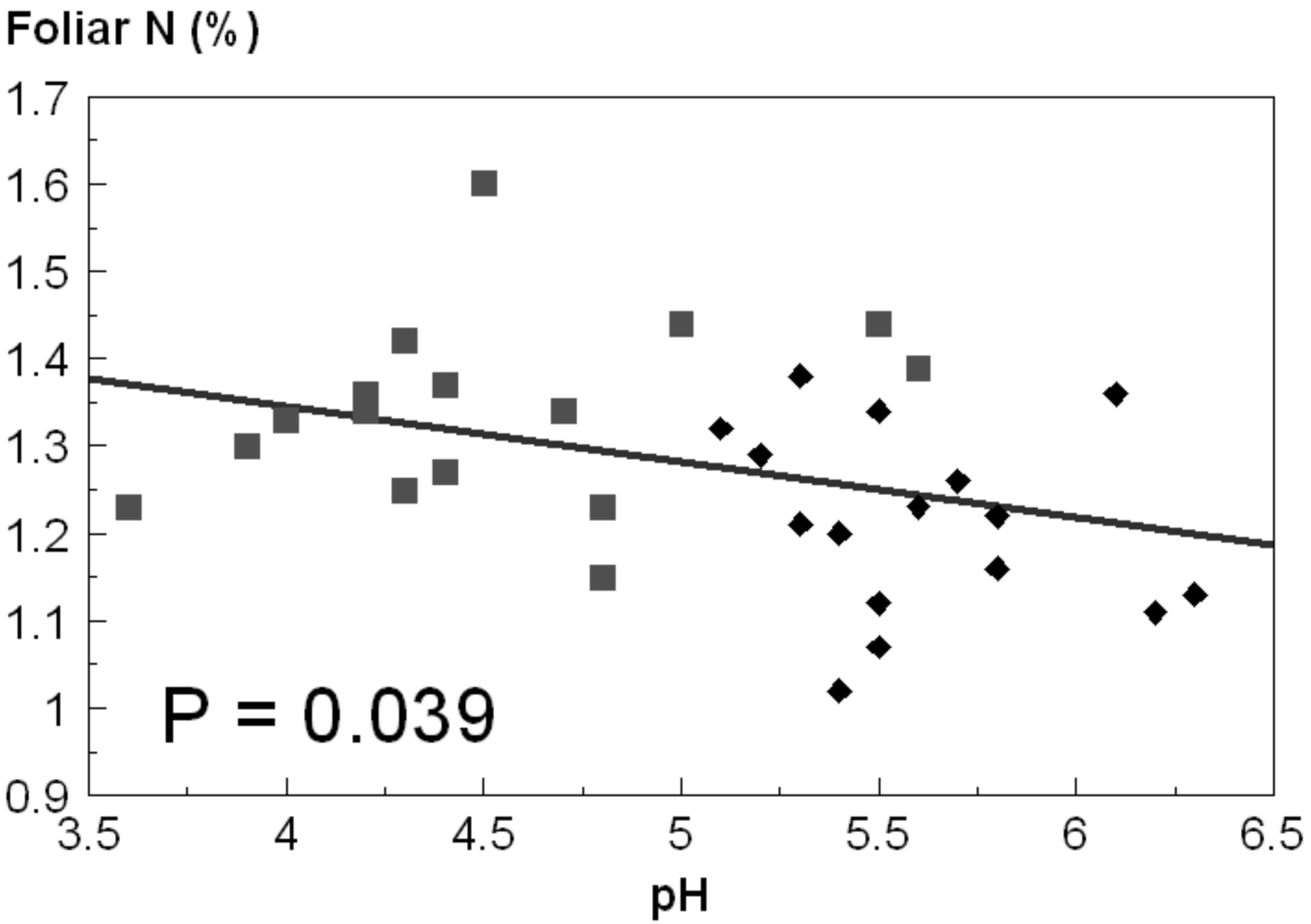


Zn had no trend in Helm and Kuser 1991. Northern Journal of Applied Forestry. 8(2): 63-68.



Agrees with Helm and Kuser 1991. Northern Journal of Applied Forestry. 8(2): 63-68. and Marx 1990. Forest Science

Conclusions from the 2016 trials.

- Adding sulfur just before sowing had no detrimental effects on seedling growth (when followed by above average rainfall). Well fertilized seedlings can be grown at pH 3.6-3.9.

- Adding sulfur can reduce the level of soil cations (Ca, K, Mg)

- Adding lime just before sowing had no detrimental effect on seedlings and did not result in chlorosis at pH 6.3.

- At this location, the effect of sulfur on soil pH appears to be faster than the effect of lime.

- There appears to be no need to lime when soil is at pH 5.4.

Conclusions from other publications.

• Adding 800 lbs/a of sulfur just before sowing may be harmful to loblolly pine seedlings when followed by below average rainfall (Carey et al. 2002).

•Adding lime to soil at pH 4.8 can reduce growth of loblolly pine seedlings (Marx 1980).

•The optimal range for bareroot pine seedlings is likely pH 4.5 to 5.5 (South 2017).

QUESTIONS?

Photo by Gene Bickerstaff