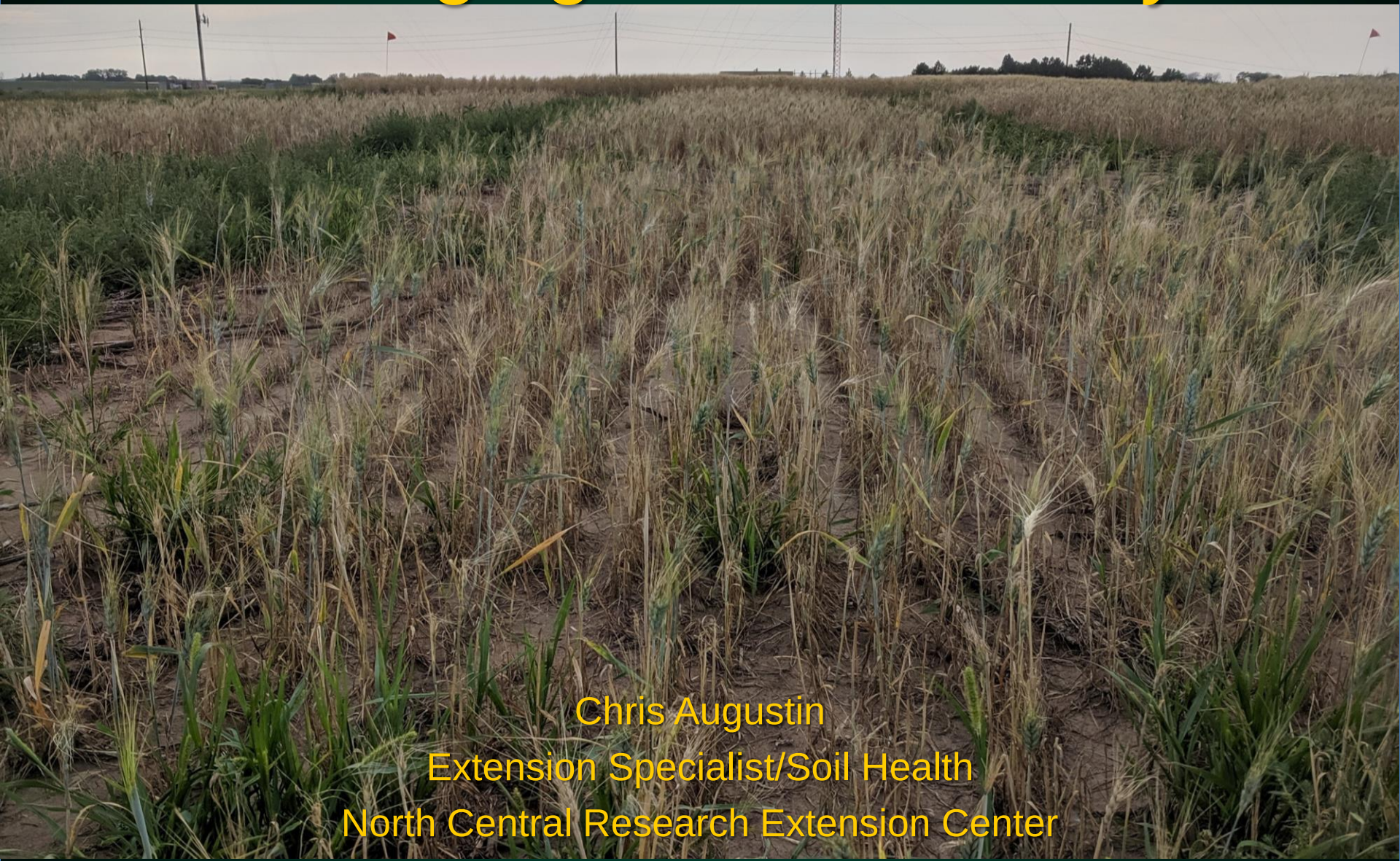
Managing Surface Acidity



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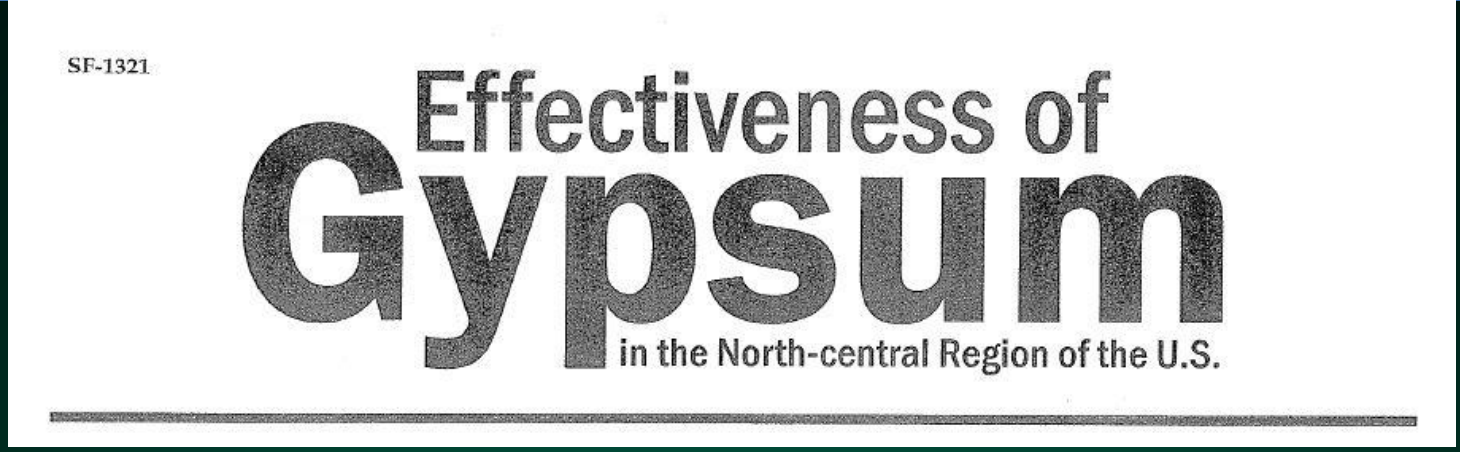
Main Points

- Salinity = salt = you can see it
- Sodicity = Sodium = you can see it (structure)
- Acid = pH < 7
- Alkaline = pH > 7 = you can see it (chalk, not salt)
- Alkali = Old term for sodicity


Salinity, E.C.>2 mmohs/cm

Sodicity, SAR>13 or ESP > 15

Courtesy of Dr. Dave Hopkins and Mike Ulmer



- Reclaim sodic soils
  - Need to know CEC (not summation)
  - SAR
  - Ca content of gypsum
  - Bulk Density
- Not an effective liming product
- Does not improve iron chlorosis
- Can add S, but has low solubility

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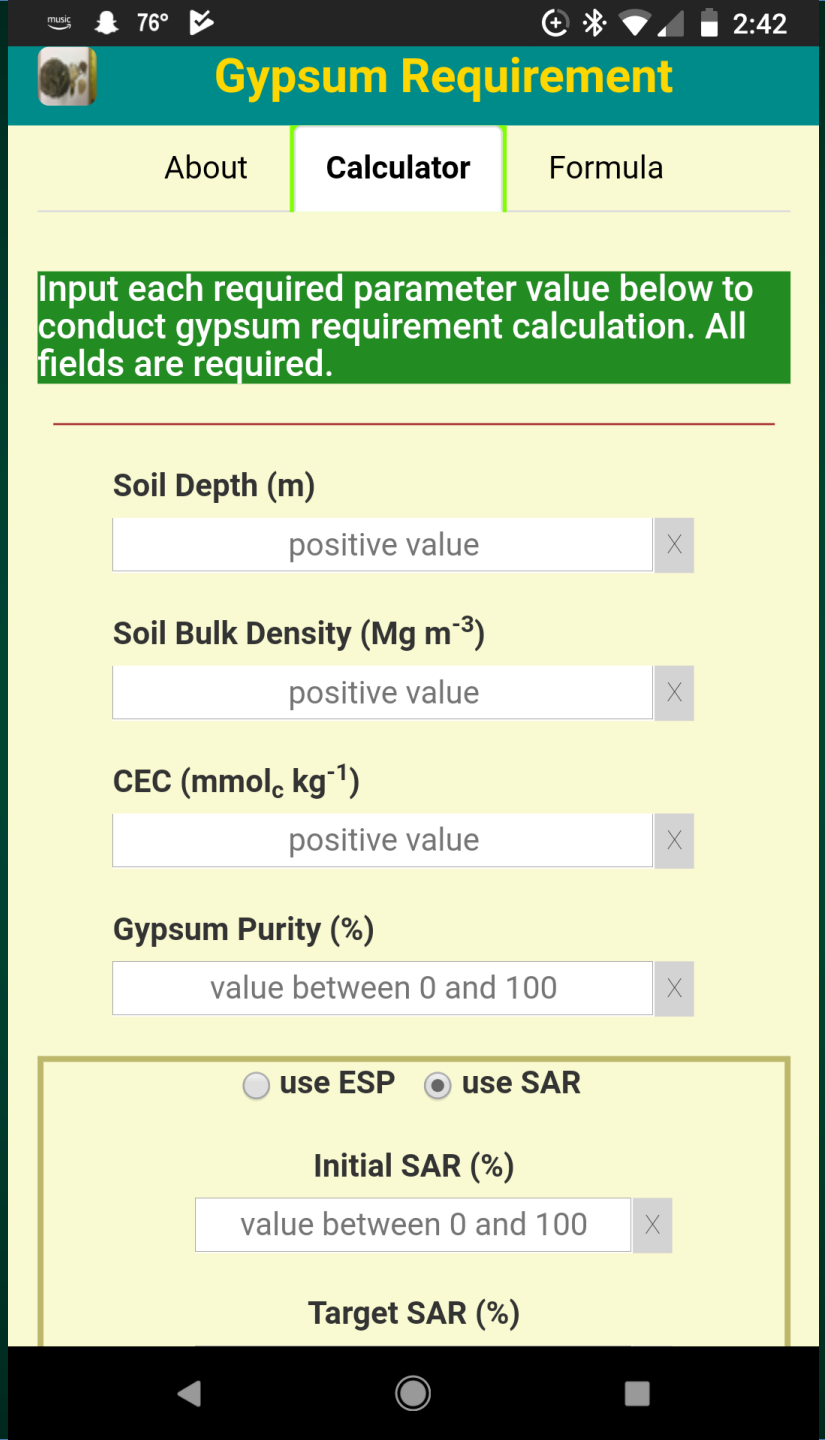
Franzen et al., 2006



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Soil pH

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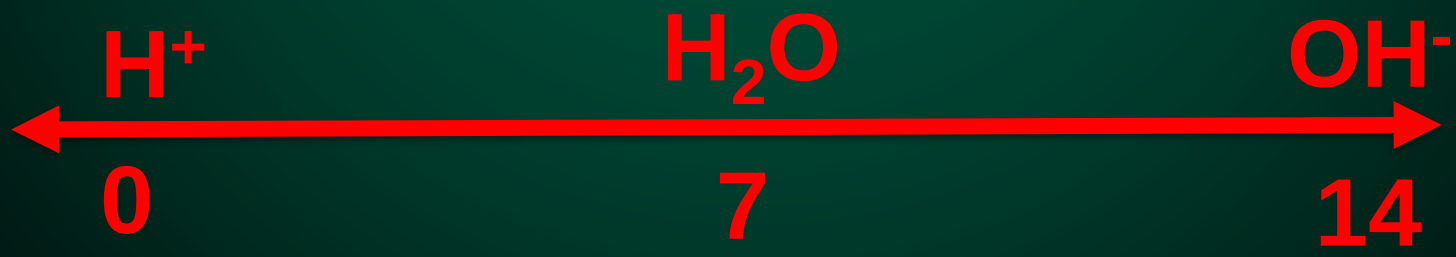
- pH is the concentration of the negative log of Hydrogen in a solution.
- pH 3 = 0.001 M H^+
- pH 5 = 0.00001 M H^+
- pH 7 = 0.0000001 M H^+
- pH 9 = 0.000000001 M H^+
- A change 1 unit pH is a factor of 10. So change of pH from 4 to 6 is a factor of 100



Causes of soil pH

- Parent materials
  - Granite and volcanic ash are acidic
  - Limestone and ocean sediments are alkaline
- Nitrogen fertilizer
  - $CO(NH_2)_2 + 2H_2O + H^+ \blacktriangleright NH_3 + H_2O + H^+ \blacktriangleright NO_2^- \blacktriangleright NO_3^-$
- Over time the soil acidifies and frees up aluminum. Clays are made up of aluminum and silicates.

Acidic Soil Issues

- pH less than 5.5 reduces microbial activity.
- Occurs when pH < 5.5 and Al^{+3} is freed up.
- Al^{+3} is 25 ppm or >
- As Al^{+3} frees up, it splits H_2O and attached to OH^-. This frees up H^+ and acidifies even more.
- Al^{+3} ties up P. Early on it can look like a P deficiency.
- As it worsens, roots are abnormally shaped or amount is reduced.
- Manganese toxicity.

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Buffer pH Soil Test

- 3 types of acidity
  - Active, Exchangeable, Reserve
- Buffer test measures H^+ held by CEC
  - (Exchangeable & Reserve)
- Needed to determine proper lime application
  - Tons of **pure lime** = (Desire pH- Buffer pH) X 4
  - The problem is many Buffer pH tests are near 7. This prevents the equation from working.
  - However, liming may be a 1 every 20 year thing!
  - There are other tables and equations that are region specific.

Factors Affecting Lime Effectiveness

- Time/Temperature
- Pureness of lime (Calcium Carbonate Eqivalence or CCE)
- Particle size
  - The finer the lime, the faster it dissolves
- Rainfall
  - Need moisture to dissolve
- Incorporation
  - Since acidity tends to be near the surface, incorporation isn't needed.

Liming Products

- Gypsum is not an effective liming product.

Type of Lime	Formula	CCE Range
Calcitic Limestone	$CaCO_3$	80-100
Marl (shells)	$CaCO_3$	70-90
Dolomitic Limestone	$CaMg(CO_3)_2$	110
Quick Lime	CaO	150-180
Hydrated Lime	$Ca(OH)_2$	124-140
Wood ash	MgO and other oxides	30-70

- Neutralizing an acid (H^+) is a combination of CCE and particle size.

Adapted from Thompson and Coyne. 2006. Math for Soil Scientists.

Calcium doesn't neutralize acid!

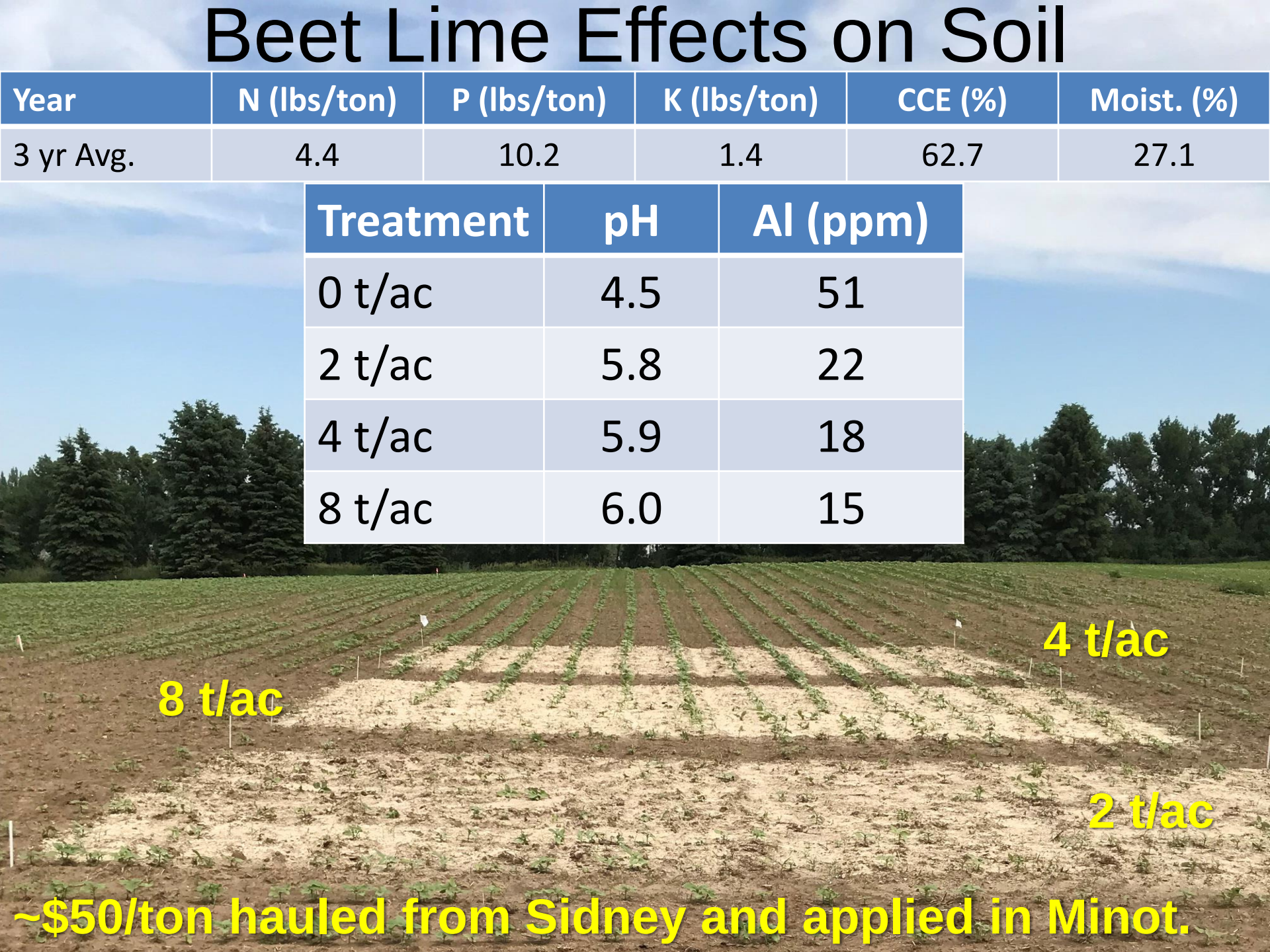
Treatment	Rate	Final pH
Check		5.1
Hydrated Lime	2 t/ac ECCE	6.2
Pell lime	100 lbs/ac	4.4
Pro Cal	3 gal/ac	4.4
Advanced Cal	3 gal/ac	4.3
Equiv Ca/HL		4.4

Adapted from No-Till Farmer January 2020. Research conducted by Brian Arnall Oklahoma State University.

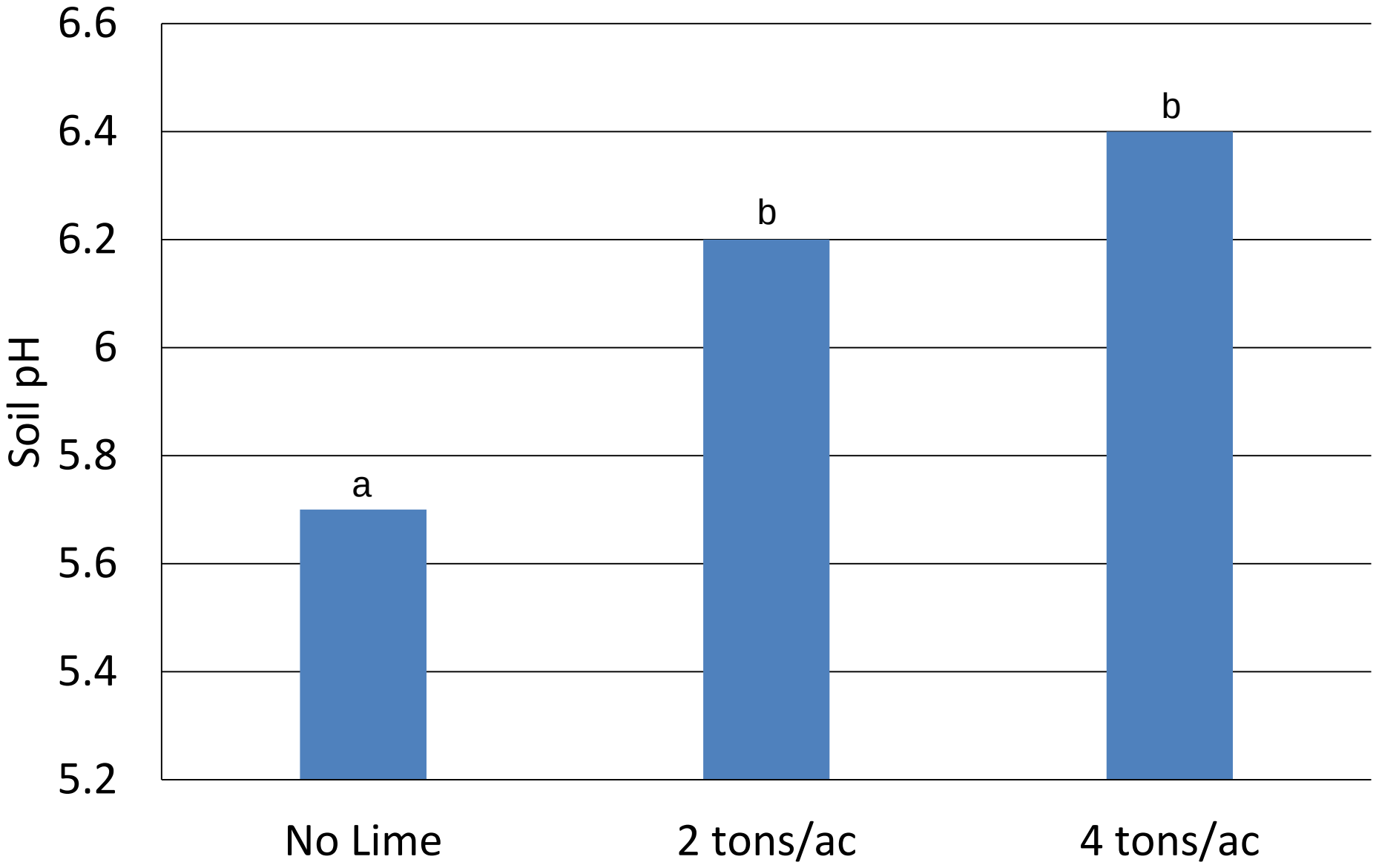
Beet Lime Effects on Soil

Year	N (lbs/ton)	P (lbs/ton)	K (lbs/ton)	CCE (%)	Moist. (%)
3 yr Avg.	4.4	10.2	1.4	62.7	27.1

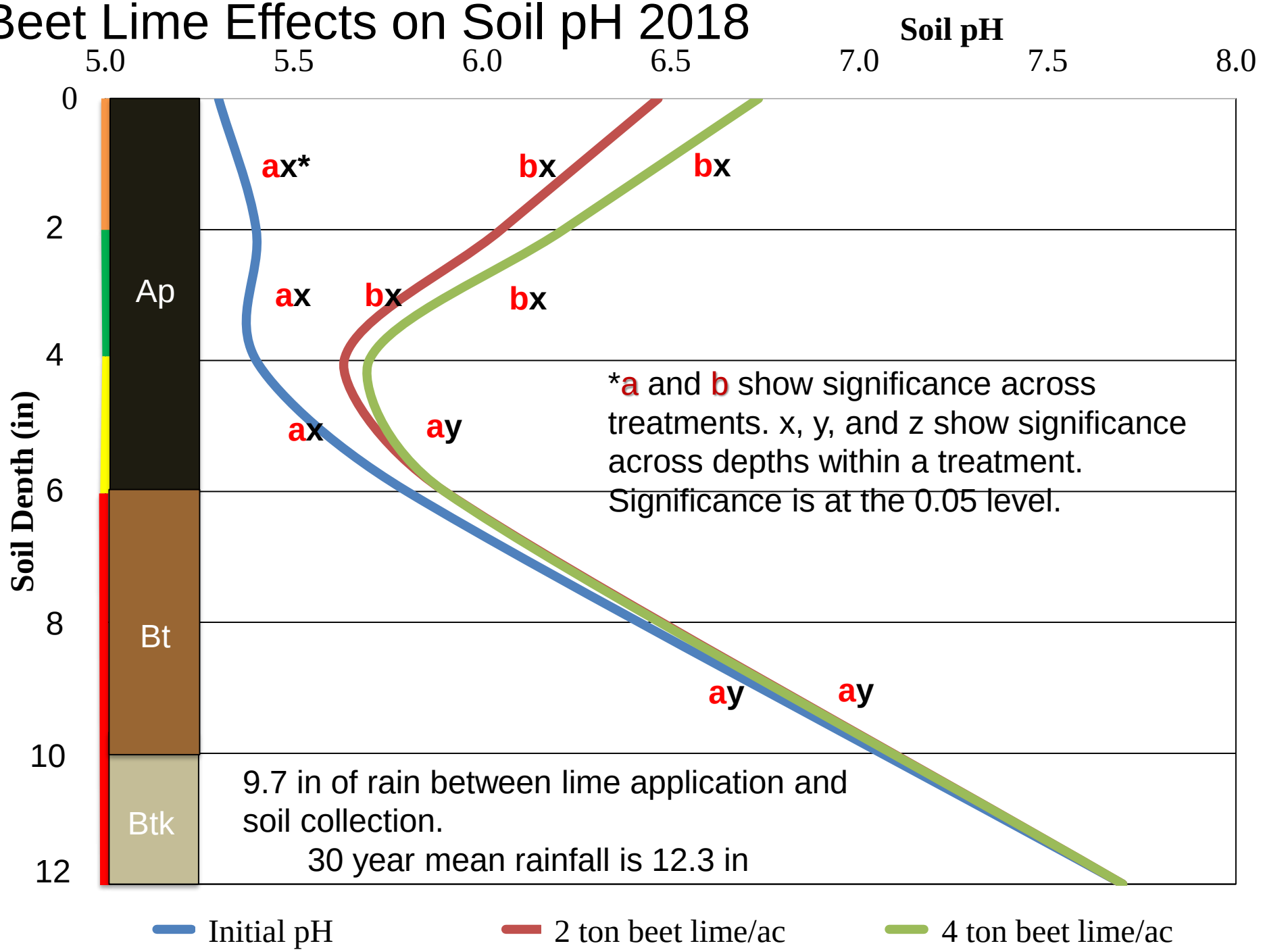
Treatment	pH	Al (ppm)
0 t/ac	4.5	51
2 t/ac	5.8	22
4 t/ac	5.9	18
8 t/ac	6.0	15



Beet Lime Soil pH Impacts on 0-6 inch Depth (2017 Growing Season)



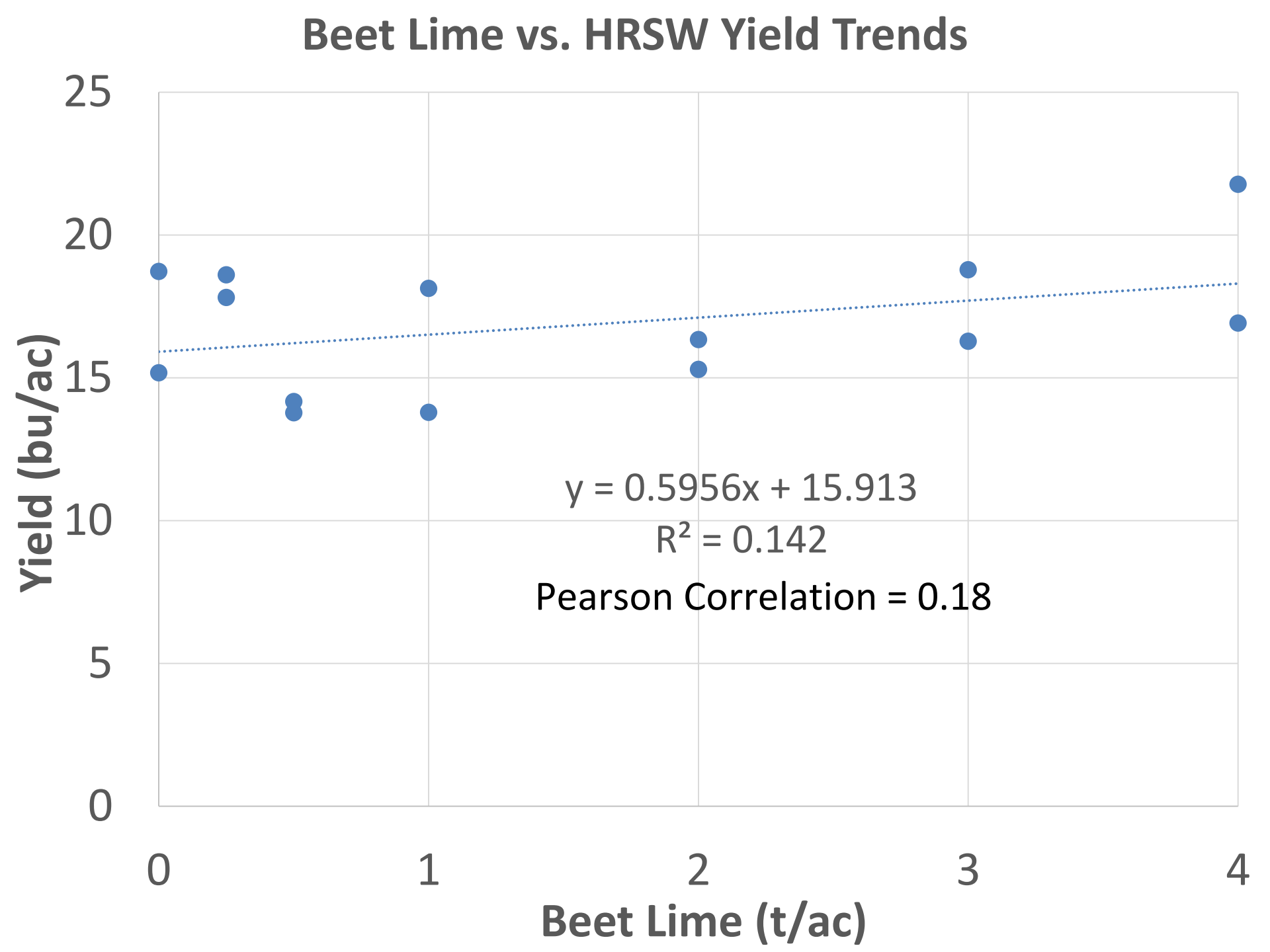
Beet Lime Effects on Soil pH 2018



Beet Lime Impacts on Wheat

Treatment	Variety	Yield (bu/ac)
4 t/ac	Soren	21.8a
3 t/ac	Soren	18.8ab
Check	Soren	18.7ab
0.25 t/ac	Soren	18.6ab
1 t /ac	Soren	18.1ab
0.25 t/ac	Lanning	17.8abc
4 t/ac	Lanning	16.9bc
2 t/ac	Soren	16.3bc
3 t/ac	Lanning	16.3bc
2 t/ac	Lanning	15.3bc
Check	Lanning	15.2bc
0.5 t/ac	Lanning	14.2c
1 t /ac	Lanning	13.8c
0.5 t/ac	Soren	13.8c

NDSU EXTENSION SERVICE P-value, 0.001; Variance 18.8; Treatments did not influence protein.


Beet Lime vs. HRSW Yield Trends
Yield (bu/ac)
25
20
15
10
5
0
0
1
2
3
4
Beet Lime (t/ac)
y = 0.5956x + 15.913
R² = 0.142
Pearson Correlation = 0.18

Soil Acidity Impacts on HRSW Cultivar

Variety	Yield	Test Weight	Aluminum	Manganese
	bu/ac	lbs/bu	Early Flag Leaf Tissue Sample (ppm)	
Soren	40c	59.3a	92	284
Alum	49b	56.3b	72	210
Glenn	51b	57.0a	54	265
Bolles	51b	57.8ab	115	278
Lanning	59a	55.5b	89	256
LSD (0.05)	5	2.3	NS	NS

Soil pH of 5.7 (0-2in), 4.5 (2-6in), & 4.2 (6-12in).

Adopted from R. Buetow, 2019.

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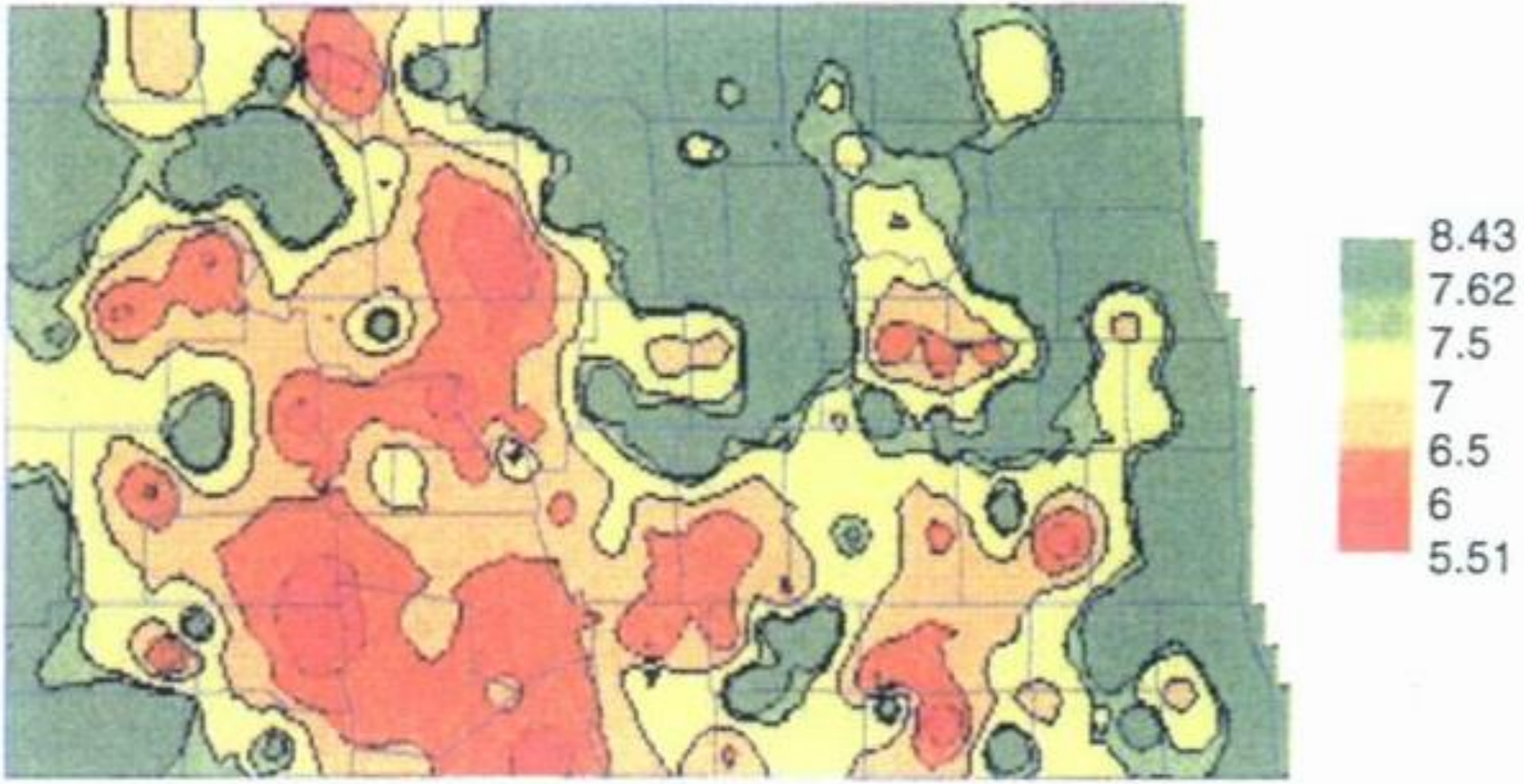
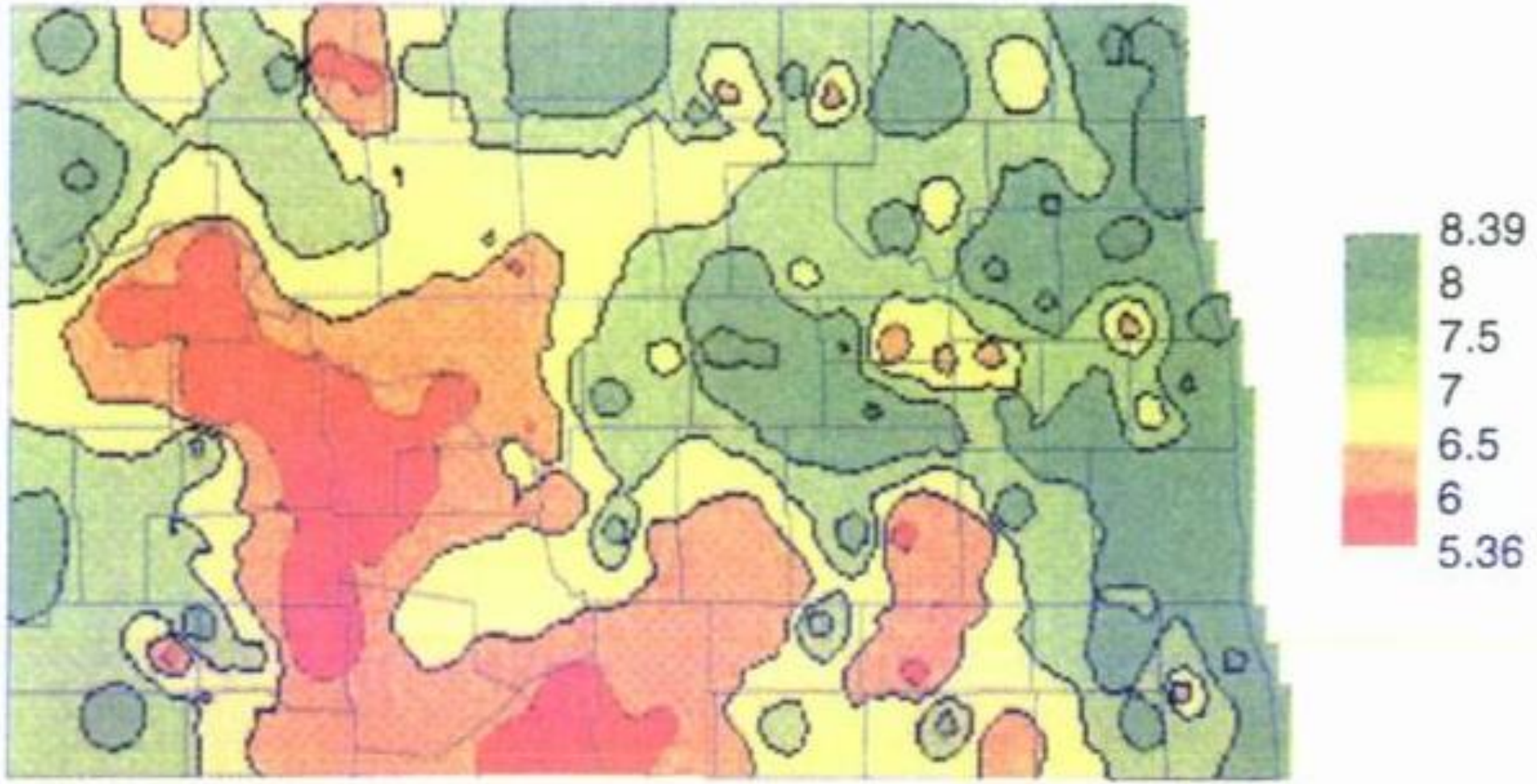
pH of Side Slopes



Franzen, 1999

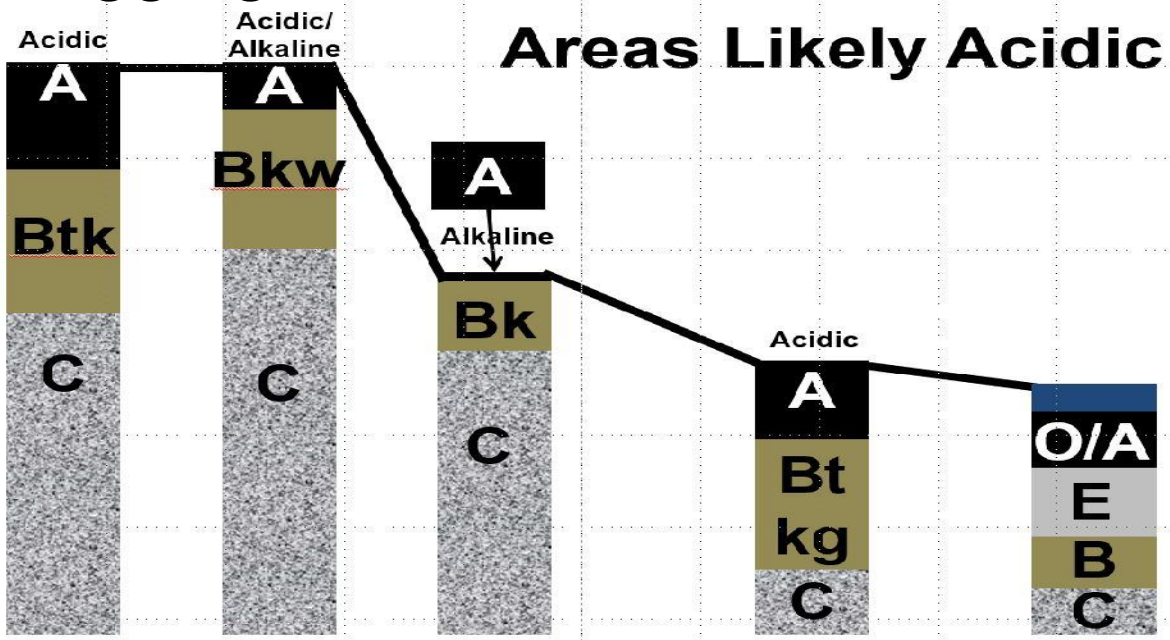
pH of Depressional Areas



Franzen, 1999

How do I find these areas?

- Zone sampling will work better than grid sampling (topography related).
- Many have reported average soil pH is OK (i.e. pH 6.5), but a composite soil sample doesn't find the acidic hotspot.
- Sample 0-3in, 3-6in for pH, and 0-6in for nutrients
- Do some digging and look for carbonates.



Summary

- pH is the concentration of hydrogen.
- Lime is for acidic soils.
- Gypsum is for sodic soils.
- Many areas may not need lime BE SITE SPECIFIC!
- We are evaluating various Buffer pH soil tests and lime determination equations.
- We’ve seen similar pH improvement with surface applied 2 and 4 ton beet lime/ac.
- $50/ton hauled from Sidney and applied in Minot.

Questions?

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