Five-Year Effect of a Single Application of Factory Waste Lime on Aphanomyces Root Rot and Sugarbeet

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Long-term Objectives

- Amount lime to reduce Aphanomyces root rot & increase yield of sugarbeet
- Duration of beneficial effects on sugarbeet
- Effects on other crops in rotation
- Mechanisms of disease suppression

Research site information

Factor	Hillsboro, ND	Breckenridge, MN
Soil type	Fargo sicl (fine, smectitic, frigid, Typic Epiaquert)	Doran cl (fine, smectitic, frigid Aquertic, arqiudoll)
Soil pH	7.0	6.3
Aph Soil Index Value	48	98
Date limed	October, 2003	April, 2004
Rates (Ton wet wt/A)	0, 5, 10, 20, 30	0, 5, 10, 15, 20
Rates (Ton dry wt/A)	0, 3.3, 6.5, 13, 19.5	0, 2.7, 5.3, 8, 10.6

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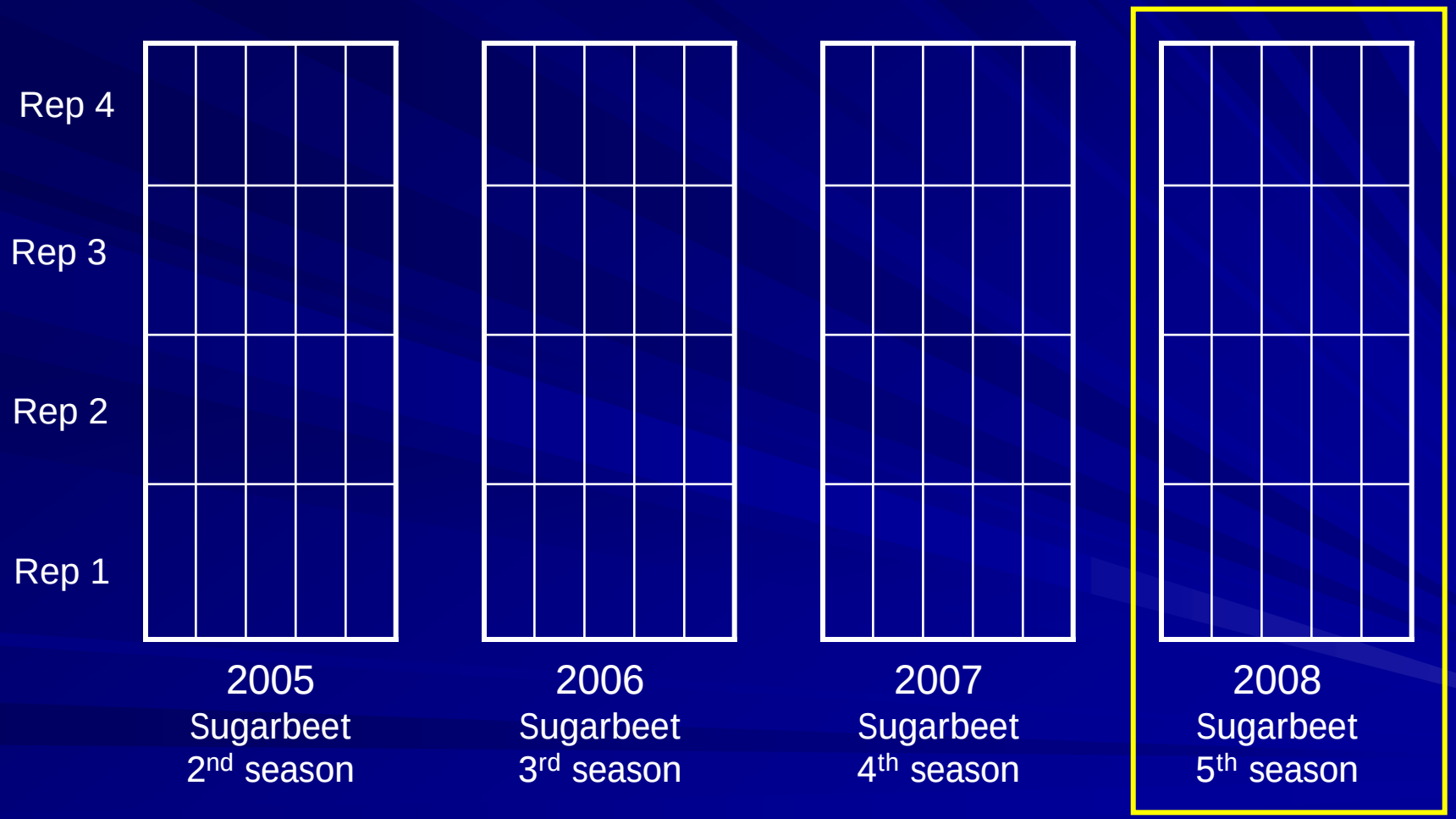
Rates (Ton wet wt/A)	0, 5, 10, 20, 30	0, 5, 10, 15, 20
Rates (Ton dry wt/A)	0, 3.3, 6.5, 13, 19.5	0, 2.7, 5.3, 8, 10.6

Experiments (2005 – 2008)

Sugarbeet sown in 1 experiment & rotation crops in other 3 experiments



Results: Sugarbeet

- 2008 (5th growing season after application)
- 2005-2008 (summary)
  - Soil pH
  - Aphanomyces root rot
  - Yield & quality

2008: Hillsboro

Lime (T/A)	Stand 5 WAP/80' row	No. Roots Harv/80 ft
0	165	89
5	184	90
10	175	88
20	180	91
30	187	87
Linear	*	NS
Quadratic	NS	NS

*=significant at *P* =0.05, **=significant at *P* =0.01, NS = not significant

2008: Hillsboro

Lime (T/A)	Stand 5 WAP/80' row	No. Roots Harv/80 ft	Aph RRR (0-7)	Yield (ton/A)	Sucrose lb rec./A
0	165	89	2.6	24.6	7595
5	184	90	2.0	26.0	8046
10	175	88	2.1	25.8	7771
20	180	91	2.1	27.0	8194
30	187	87	2.0	25.8	7866
Linear	*	NS	**	NS	NS
Quadratic	NS	NS	NS	NS	NS

*=significant at *P* =0.05, **=significant at *P* =0.01, NS = not significant

2008: Breckenridge

Lime (T/A)	Stand 5 WAP/80' row	No. Roots Harv/80 ft
0	155	78
5	176	99
10	176	98
15	182	98
20	184	99
Linear	NS	**
Quadratic	NS	**

*=significant at *P* =0.05, **=significant at *P* =0.01, NS = not significant

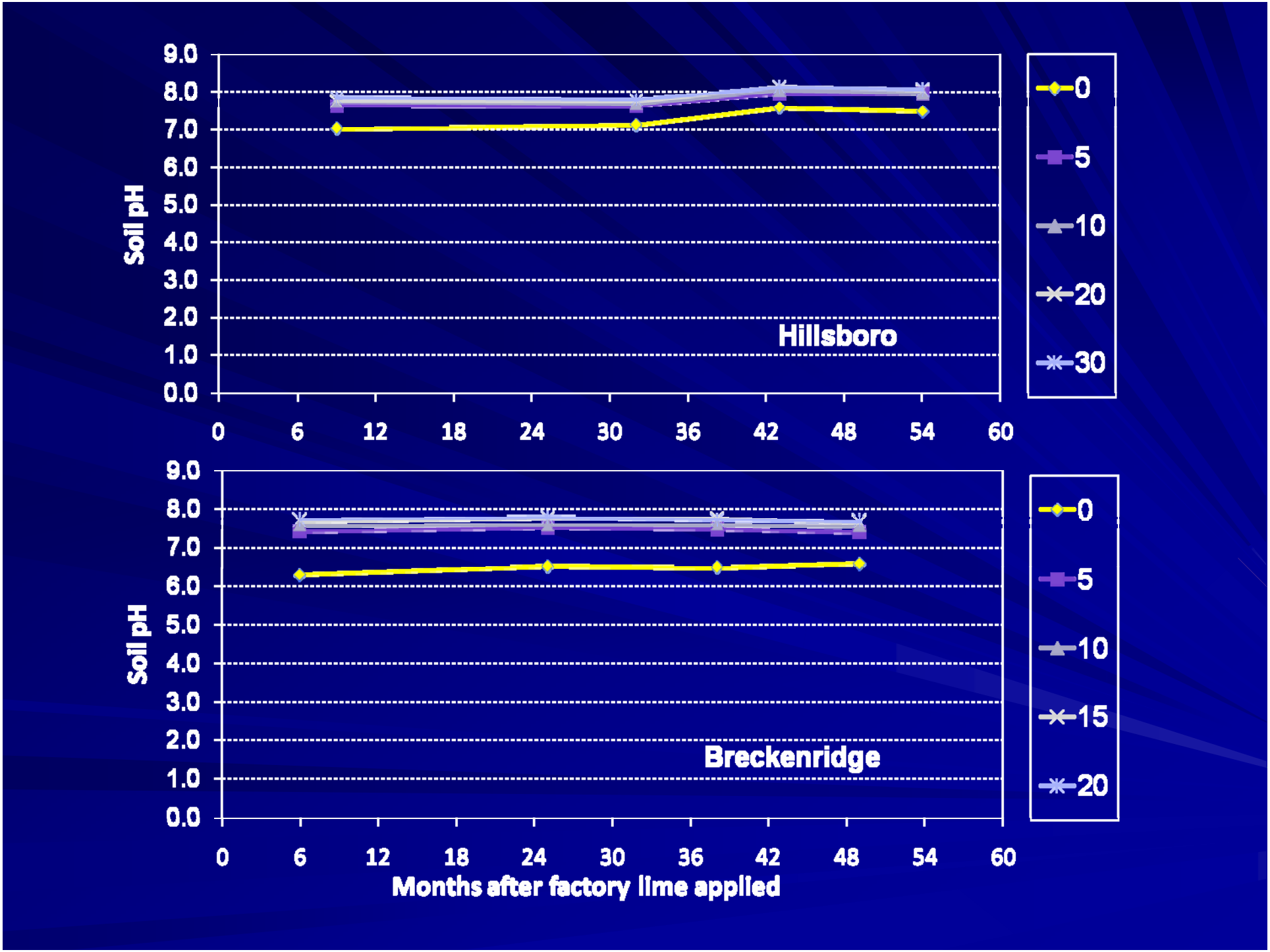
2008: Breckenridge

Lime (T/A)	Stand 5 WAP/80' row	No. Roots Harv/80 ft	Aph RRR (0-7)	Yield (ton/A)	Sucrose lb rec./A
0	155	78	3.8	21.0	5546
5	176	99	3.0	27.4	7514
10	176	98	3.0	27.7	7326
15	182	98	2.6	29.8	8000
20	184	99	2.9	29.7	7860
Linear	NS	**	**	**	**
Quadratic	NS	**	**	**	**

*=significant at *P* =0.05, **=significant at *P* =0.01, NS = not significant

2005 -2008

- Location variability from year-to-year
  - Weather
  - Disease severity
  - Sugarbeet variety


Soil pH
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
6
12
18
24
30
36
42
48
54
60
Hillsboro
0
5
10
20
30
Soil pH
Breckenridge
0
5
10
15
20
Months after factory lime applied

2005 - 2008: Hillsboro

Lime (T/A)	Stand 4 WAP/80' row	No. Roots Harv/80 ft
0	256	112
5	269	117
10	265	120
20	273	122
30	273	122
Linear	***	NS
Quadratic	NS	NS

=significant at *P* =0.001, *=significant at *P* =0.0001, NS = not significant

2005 - 2008: Hillsboro

Lime (T/A)	Stand 4 WAP/80' row	No. Roots Harv/80 ft	Aph RRR (0-7)	Yield (ton/A)	Sucrose lb rec./A
0	256	112	2.2	22.2	6827
5	269	117	1.9	23.2	7333
10	265	120	2.0	24.3	7490
20	273	122	2.0	24.2	7562
30	273	122	1.9	24.6	7896
Linear	***	NS	***	****	****
Quadratic	NS	NS	NS	NS	NS

=significant at *P* =0.001, *=significant at *P* =0.0001, NS = not significant

2005 - 2008: Breckenridge

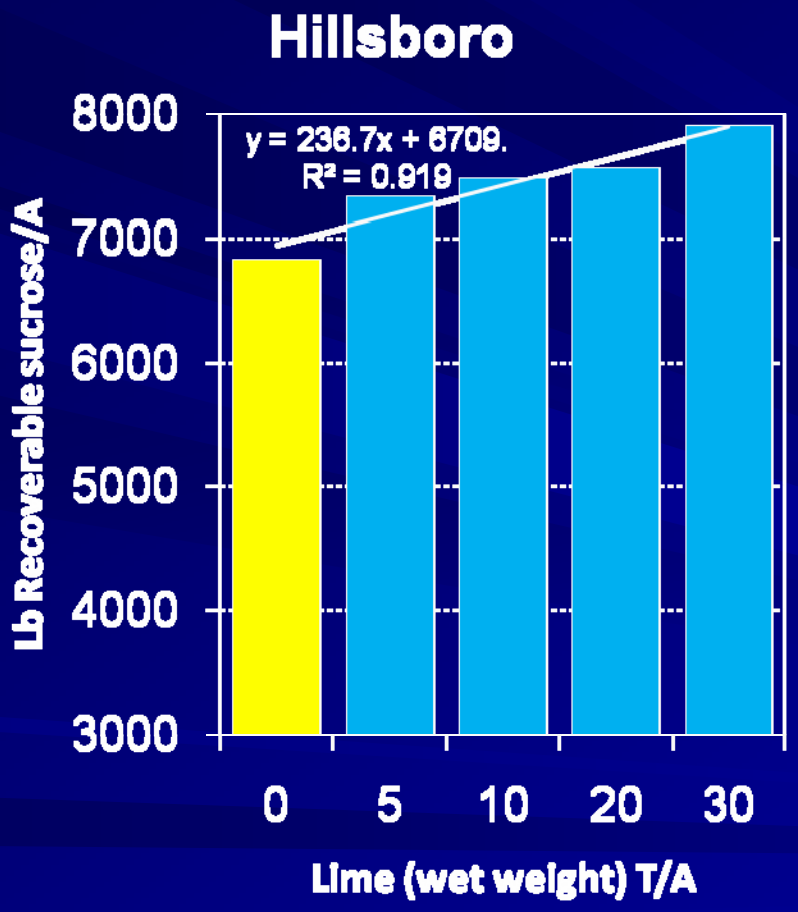
Lime (T/A)	Stand 4 WAP/80' row	No. Roots Harv/80 ft
0	202	58
5	223	83
10	233	93
15	230	91
20	238	96
Linear	****	****
Quadratic	*	****

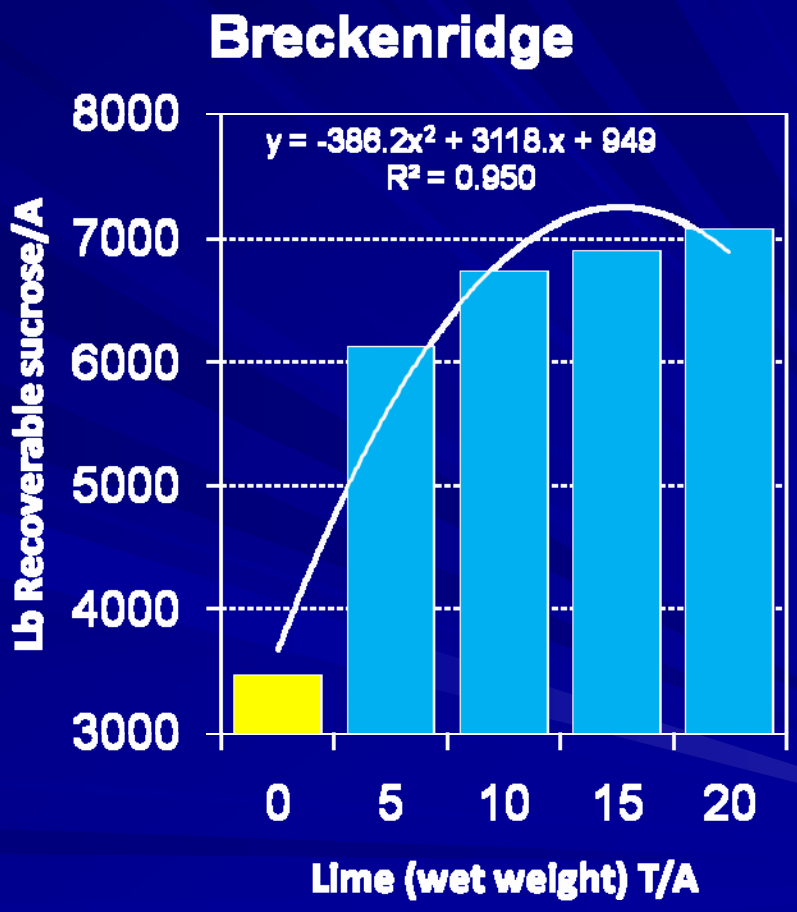
*=significant at *P* =0.05, ****=significant at *P* =0.0001, NS = not significant

2005 - 2008: Breckenridge

Lime (T/A)	Stand 4 WAP/80' row	No. Roots Harv/80 ft	Aph RRR (0-7)	Yield (ton/A)	Sucrose lb rec./A
0	202	58	4.9	13.2	3459
5	223	83	3.6	22.4	6120
10	233	93	3.3	24.5	6730
15	230	91	3.2	25.4	6898
20	238	96	3.2	26.0	7076
Linear	****	****	****	****	****
Quadratic	*	****	****	****	****

*=significant at *P* =0.05, ****=significant at *P* =0.0001


Hillsboro
y = 236.7x + 6709.
R² = 0.919
8000
7000
6000
5000
4000
3000
Lb Recoverable sucrose/A
0
5
10
20
30
Lime (wet weight) T/A


Breckenridge
y = -386.2x² + 3118.x + 949
R² = 0.950
8000
7000
6000
5000
4000
3000
Lb Recoverable sucrose/A
0
5
10
15
20
Lime (wet weight) T/A

Conclusions: Soil application of spent lime

- Aphanomyces root rot reduced
- Root and sucrose yields increased
- Soil pH increased within few months and values have remained relatively stable through 2008
- All rates of lime were beneficial
  - MPCA- not to exceed 10 tons dry weight per acre

Acknowledgements

- Sugarbeet Research & Education Board
- UM Rapid Agricultural Response Fund
- Chad Kritzberger, Hillsboro cooperator
- Pat Freese, Breckenridge cooperator
- Tim Leshuk, Cody Kritzberger, American Crystal agriculturists
- Jon Warner, Mark Borud, Mike Metzger, Minn-Dak agriculturalists
- Mary Johnshoy, Kim Hoff, Jeff Nielsen (UM, NWROC)
- Lenny Luecke & other NDSU colleagues
- American Crystal and Seedex: AC Quality Lab, EGF

Why? More questions than answers

- How does lime alter physical, chemical & biological interactions in soil?
  - Soil, plant, *Aphanomyces*, other microorganisms
- Examples:
  - Soil aggregation
  - pH – changes availability of nutrients
  - Excess Ca affect infectivity *Aphanomyces*
- Identify physical, chemical, and biological factors over a range of soil pH values, soil types, etc.