4th Annual

Midwest Soil Improvement Symposium: 2014

Research and Practical Insights into Using Gypsum

Practical Use of Gypsum For Crop Production

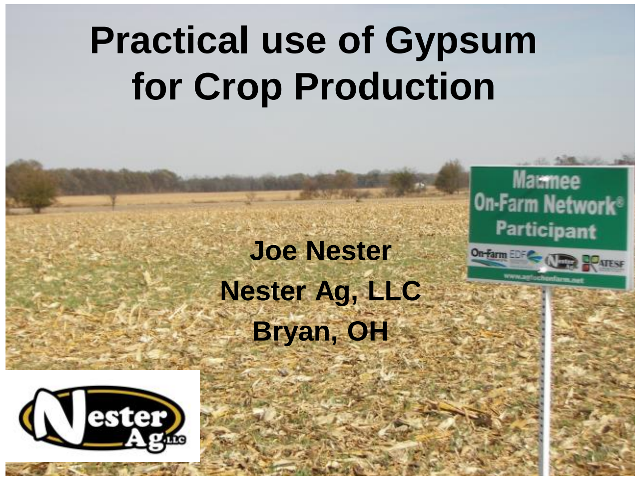
Joe Nester

Agronomist and Owner

Nester Ag LLC

Bryan, OH

AUGUST 13, 2014



Key Points

- Soil Quality Impact
- Nutrient Recoverability
- Water Infiltration / Air in the Soil
- Importance of Structure
- Crop Stress and Duration
- Gypsum Applications
- Possible Cause of DRP Issues

Several Ways to Succeed Farming

- Some are More Profitable than Others
- Some have More Risk
- Very Complicated Science
- Some want EASY BUTTON
- Easy to Blame Wrong Practice

Nutrient Requirement

- = (Efficiency X Nutrient Saturation) – Loss, - Tie Up, + Placement Factor, + or- Source, + or – Timing

- E= (Root Mass – Stress Accumulation)
- SA Debits= (Water, Lack of Air, Herbicide Effect, Disease, Insect, Heat/Cold, Compaction, Stand Variation)
- SA Credits= (Soil Air, Water, Biological Populations, Soil Structure)

- **The Soil is a Living Thing**
  - **This is where the profit is**

- **As land values, crop values, input costs, and water quality all increase, this becomes more important**

Facts

- Soil Water and Air have more Effect on Yield than Nutrient Levels
- The Grower that can Manage Soil Structure and Health, in Concert with Nutrients, Wins
- **IT'S ABOUT MINIMIZING STRESS and DURATION**

Nutrient Management

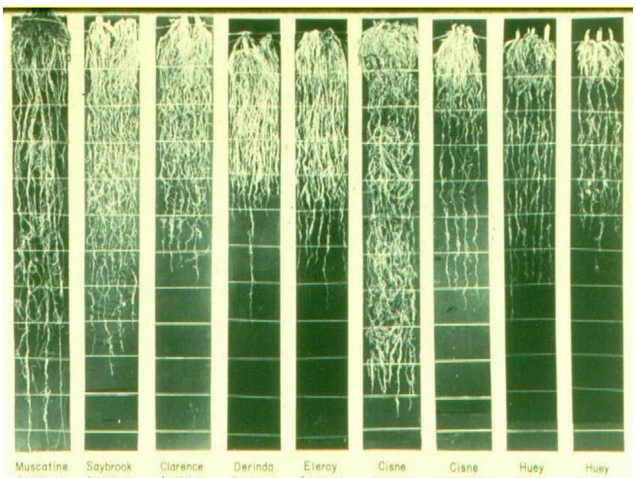
- A Soil with Good Structure, Ample Microbial Life, and a Decent Water Infiltration Rate Needs <u>Less Nutrients on Paper</u>
- The Key is:
- **RECOVERABILITY!**

GOOD SOIL STRUCTURE

- The arrangement of soil particles, with respect to each other,into a pattern that moves water and air freely and enhances biological soil life.

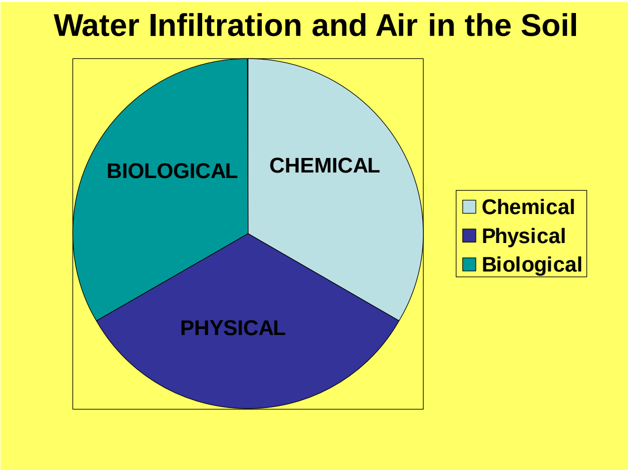
Soil Structure Influences

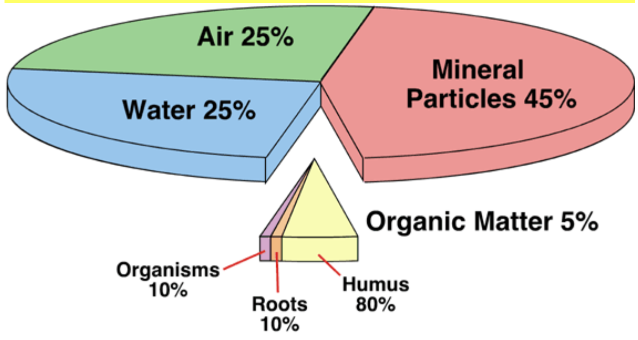
- Water Supply
- Aeration
- Nutrient Availability
- Microbial Activity
- Root Penetration
- Temperature
  - (Disease)
- Residue Decomposition



Soil Testing

- Labs Vary in Methodology
- Soil Structure/ Health does **<u>NOT</u>** show on the Test
- (Today) ??!!





Soil Structure 101

- BUILD WATER STABLE AGGREGATES!

How do you Build Water Stable Aggregates

- CaCO3 precipitated around particles
- Plants excreting gelatin-like compounds
- Root hairs, root pressures, CO2
- Dehydration by roots

Humus Associated Cations

- ONLY Calcium can flocculate
- Mg, K, H, Na peptize

and do not aid in aggregation

Algae, Fungi, Actinomyces, & Bacteria

- Hold soil particles together better than cations
- Earthworms, mites, springtails, etc.

CONSIDER LONG TERM WATER and AIR in YOUR SOIL

- If you set up a condition that move water and air in all directions, plants will thrive.

Generally - Best Ag Soils Contain 10-20% Clay

- Hoytville = 50%
- Paulding = 65%
- Many Soils in WLEB 40-50%
- OUR CLAYS GO INTO SUSPENSION

There is a Profound Difference Between Calcium and Magnesium and the way they React with Clay

- On Higher CEC Soils with Clay- Manage the Soil Structure Characteristics of Ca++ and Mg++
- Both can Purge H+ and correct pH
- On Low CEC you MUST use SLAN

Water Infiltration is the Key: Different Particle Size and Different Reaction With Clay

- Ca++ Flocculates
- Mg++ Peptizes (Disperses Clay)

WLEB Gypsum Research

The Ohio State University

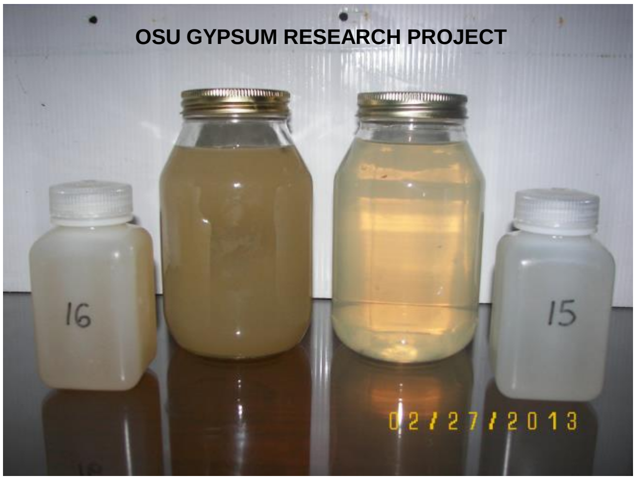
Dr. Warren Dick

Electrical Power Research Institute

Nester Ag, LLC

Plot Layout

- Consistent Soils
- Segregated Tile Outlets
- 1 Ton Gypsum Applied
- Water Samples During Tile Flow



		Dissolved Orthophosphate		
Grower	Date	with gypsum	without gypsum	% reduction
A	6/13/13	0.069	0.154	55.2
	6/19/13	0.071	0.13	45.4
	6/19/13	0.067	0.119	43.7
	7/3/13	0.086	0.158	45.5
	7/15/13	0.062	0.207	70.0
	7/15/13	0.069	0.207	66.7

April 2012 Application

		Dissolved Orthophosphate		
Grower	Date	with gypsum	without gypsum	% reduction
B	6/19/13	0.022	0.034	35.3
	6/19/13	0.029	0.033	12.1
	7/3/13	0.021	0.042	50.0
	7/15/13	0.025	0.046	45.7
	7/15/13	0.021	0.042	50.0
	7/24/13	0.032	0.088	63.6
	7/24/13	0.036	0.102	64.7

April 2013 Application

Water Quality Benefits

Samples were collected from the Rolland Wolfrum Hale Farm (Hicksville, OH) on December 20, 2012.

In all we have collected 162 samples, to date, and the soluble P from gypsum treated soils averaging over 50% reduction.

		Sulfur		
Grower	Date	with gypsum	without gypsum	% increase
A 13	12/23/13	200.37	66.57	201%
	12/23/13	200.85	66.42	202%
	12/24/13	234.33	83.10	182%
B 12	12/23/13	158.85	48.87	225%
	12/23/13	162.74	99.87	63%
	12/24/13	267.15	101.28	164%

		Sulfur		
Grower	Date	with gypsum	without gypsum	% increase
C12	12/24/13	45.45	20.27	124%
	12/24/13	45.12	20.07	125%
D13	12/23/13	114.84	17.93	540%
	12/23/13	113.22	17.77	537%

		Magnesium		
Grower	Date	with gypsum	without gypsum	% increase
A13	12/23/13	23.02	12.03	91%
	12/23/13	23.21	11.89	95%
	12/24/13	27.13	13.97	94%
B12	12/23/13	23.31	12.10	93%
	12/23/13	24.23	11.79	106%
	12/24/13	35.15	17.28	103%
	12/24/13	35.66	17.54	103%

		Magnesium		
Grower	Date	with gypsum	without gypsum	% reduction
C12	12/24/13	16.93	15.17	12%
	12/24/13	16.99	14.96	14%
D13	12/23/13	19.27	11.68	65%
	12/23/13	19.05	12.02	58%

Gypsum Applications

- Results Depend on Ability to Leach Mg
- <12 CEC - 1000# *
- 12-15 CEC- 1500#
- 15+ CEC- 2000#
- 1 year and re-test

- Beware on low CEC soils
- SULFUR DEFICIENCIES ARE HERE!

Sulfur Nutrition

- Elemental S
  - When does it become available???
  - Needs Microbial Action
  - Solubility
  - pH
- AMS
  - cost
  - pH

Sulfur Nutrition

- Gypsum
  - pH neutral
  - 3 to 5 year Supply
  - Depending on Soil Quality
  - Soluble Calcium into B Horizon
  - Enough S to leach Mg

lb/A 35554-94

BROOKSIDE LABORATORIES, INC.

SOIL AUDIT AND INVENTORY REPORT

Name Nester Ag, LLC. City Bryan State OH

Independent Consultant Nester Ag, LLC. Date 4/25/2014

GYPSUM 1 TON October 2013

Sample Location NESTER		JN2	JN2				
Sample Identification		GYP	NO GYP				
Lab Number		0806-1	0807-1				
Total Exchange Capacity (ME/100 g)		20.67	14.39				
pH	Buffer (SMP/Sikora)	6.9	7.0				
	H_2O (1:1)	5.4	5.9				
Organic Matter (humus) %		3.35	2.85				
Estimated Nitrogen Release	lb/A	84	77				
ANIONS — SOLUBLE SULFUR*	ppm	75	12				
PHOSPHORUS — MEHLICH III	lb/A P as P_2O_5	101	101				
	ppm of P	22	22				
PHOSPHORUS — BRAY II	lb/A P as P_2O_5						
	ppm of P						
PHOSPHORUS — OLSEN	lb/A P as P_2O_5						
	ppm of P						
EXCHANGEABLE CATIONS — CALCIUM*	lb/A	4156	3632				
	ppm	2078	1816				
MAGNESIUM*	lb/A	398	362				
	ppm	199	181				

lb/A 39295-114

BROOKSIDE LABORATORIES, INC.

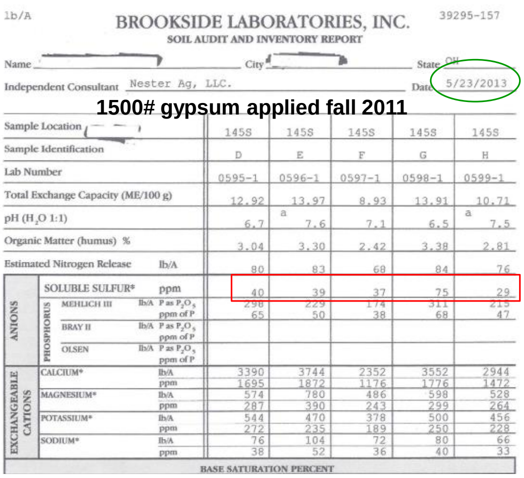
SOIL AUDIT AND INVENTORY REPORT

Name [redacted] City [redacted] State OH

Independent Consultant Nester Ag, LLC. Date 4/12/2011

Sample Location [redacted]		145S	145S	145S	145S	145S
Sample Identification		D	E	F	G	H
Lab Number		0116-1	0117-1	0118-1	0119-1	0120-1
Total Exchange Capacity (ME/100 g)		12.29	13.07	9.21	12.52	10.90
pH (H_2O 1:1)		6.6	a 7.6	7.1	6.4	a 7.5
Organic Matter (humus) %		2.57	2.80	2.08	3.27	2.42
Estimated Nitrogen Release	lb/A	71	76	62	83	68
ANIONS — SOLUBLE SULFUR*	ppm	11	11	11	13	11
PHOSPHORUS — MEHLICH III	lb/A P as P_2O_5	197	151	114	284	179
	ppm of P	43	33	25	62	39
PHOSPHORUS — BRAY II	lb/A P as P_2O_5					
	ppm of P					
PHOSPHORUS — OLSEN	lb/A P as P_2O_5					
	ppm of P					
EXCHANGEABLE CATIONS — CALCIUM*	lb/A	3080	3406	2348	3044	2840
	ppm	1540	1703	1174	1522	1420
MAGNESIUM*	lb/A	606	814	562	574	642
	ppm	303	407	281	287	321
POTASSIUM*	lb/A	424	388	328	462	412
	ppm	212	194	164	231	206
SODIUM*	lb/A	88	78	84	78	80
	ppm	44	39	42	39	40

BASE SATURATION PERCENT



lb/A

BROOKSIDE LABORATORIES, INC. 39295-157

SOIL AUDIT AND INVENTORY REPORT

Name [redacted] City [redacted] State OH

Independent Consultant Nester Ag, LLC. Date 5/23/2013

1500# gypsum applied fall 2011

Sample Location [redacted]			145S	145S	145S	145S	145S
Sample Identification			D	E	F	G	H
Lab Number			0595-1	0596-1	0597-1	0598-1	0599-1
Total Exchange Capacity (ME/100 g)			12.92	13.97	8.93	13.91	10.71
pH (H_2O 1:1)			6.7	a 7.6	7.1	6.5	a 7.5
Organic Matter (humus) %			3.04	3.30	2.42	3.38	2.81
Estimated Nitrogen Release		lb/A	80	83	68	84	76
ANIONS	SOLUBLE SULFUR*	ppm	40	39	37	75	29
ANIONS – PHOSPHORUS	MEHLICH III	lb/A P as P_2O_5	298	229	174	311	215
		ppm of P	65	50	38	68	47
	BRAY II	lb/A P as P_2O_5					
		ppm of P					
	OLSEN	lb/A P as P_2O_5					
		ppm of P					
EXCHANGEABLE CATIONS	CALCIUM*	lb/A	3390	3744	2352	3552	2944
		ppm	1695	1872	1176	1776	1472
	MAGNESIUM*	lb/A	574	780	486	598	528
		ppm	287	390	243	299	264
	POTASSIUM*	lb/A	544	470	378	500	456
		ppm	272	235	189	250	228
	SODIUM*	lb/A	76	104	72	80	66
		ppm	38	52	36	40	33

BASE SATURATION PERCENT

Everyone Wants to Blame Something

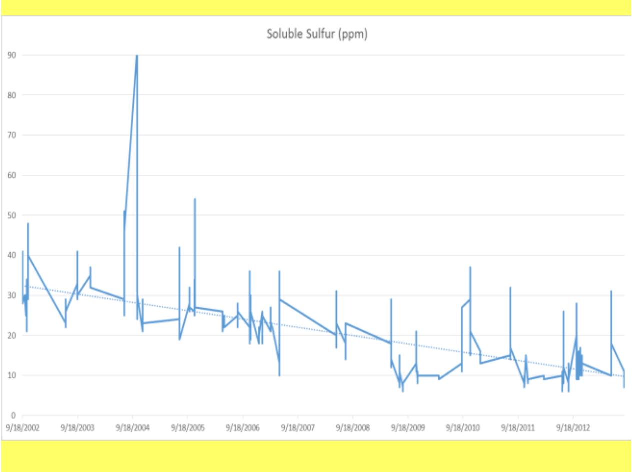
- No-till
- Tile
- No Starter on Planter
- High Rates
- Irresponsible Practices

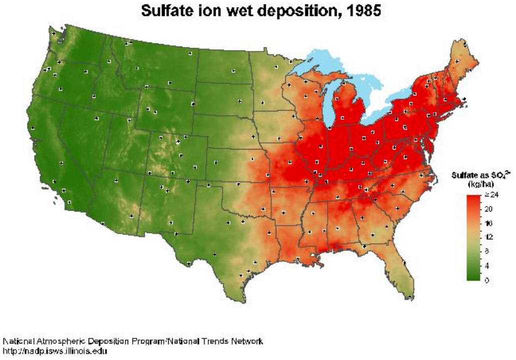
What has changed ?

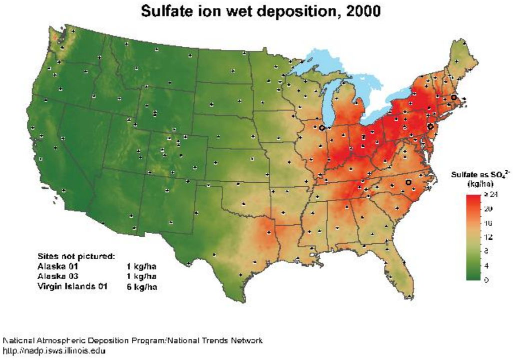
- Are Fertility Applications Guilty?
  - –Rates and Timing
- Rates of P Have Actually Decreased
- Soil Testing and VRT Have Increased Dramatically

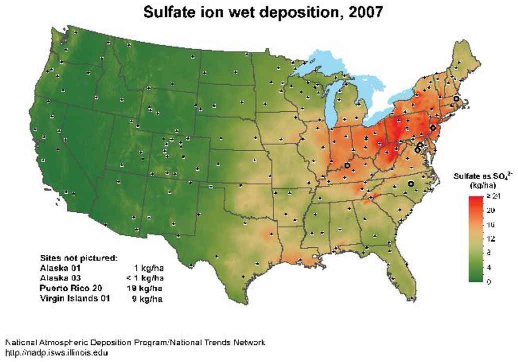
What has changed ?

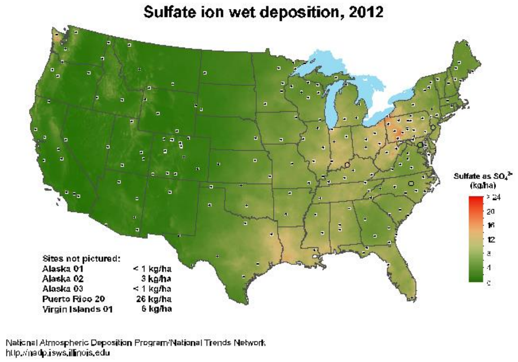
- Cover Crops
- No on Frozen Ground
- Livestock Permits

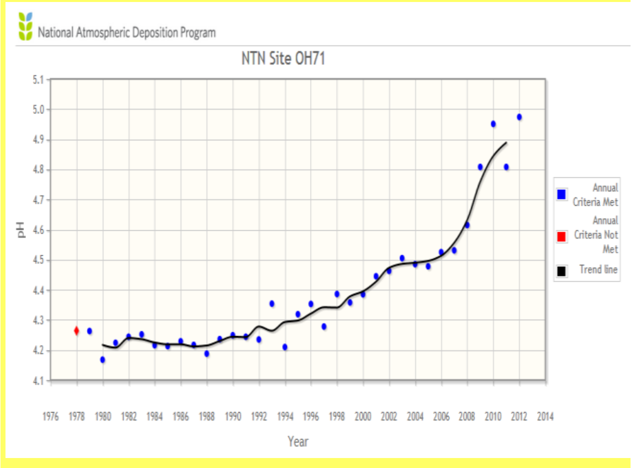


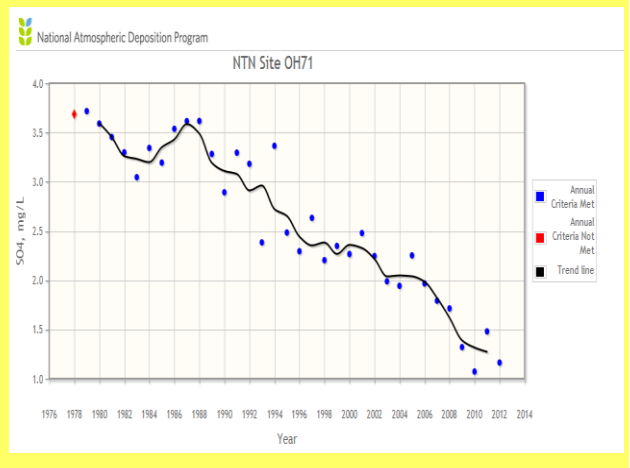


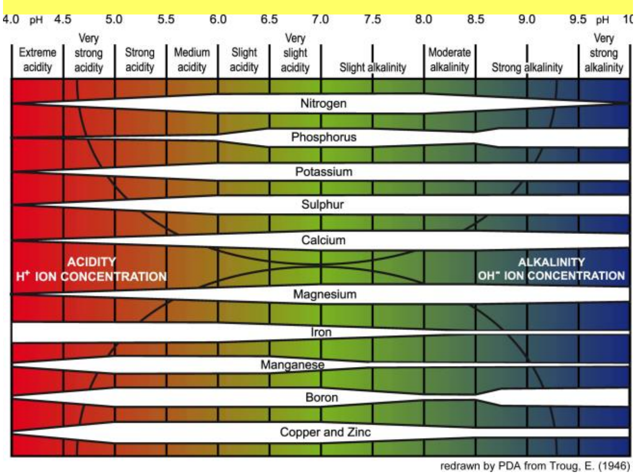



Sulfate ion wet deposition, 2007
Sulfate as SO_4^{2-} (kg/ha)
≥ 24
20
16
12
8
4
0
Sites not pictured:
Alaska 01 1 kg/ha
Alaska 03 < 1 kg/ha
Puerto Rico 20 19 kg/ha
Virgin Islands 01 9 kg/ha
National Atmospheric Deposition Program/National Trends Network
http://nadp.isws.illinois.edu


Sulfate ion wet deposition, 2012
Sulfate as SO_4^{2-} (kg/ha)
> 24
20
16
12
8
4
0
Sites not pictured:
Alaska 01 < 1 kg/ha
Alaska 02 3 kg/ha
Alaska 03 < 1 kg/ha
Puerto Rico 20 26 kg/ha
Virgin Islands 01 6 kg/ha
National Atmospheric Deposition Program/National Trends Network
http://nadp.isws.illinois.edu


National Atmospheric Deposition Program
NTN Site OH71
pH
Year
Annual Criteria Met
Annual Criteria Not Met
Trend line


National Atmospheric Deposition Program
NTN Site OH71
SO4, mg/L
Year
Annual Criteria Met
Annual Criteria Not Met
Trend line



We Strive to Maintain 6.2 to 6.8 pH in Acre Furrow Slice

7”

Sampl e depth

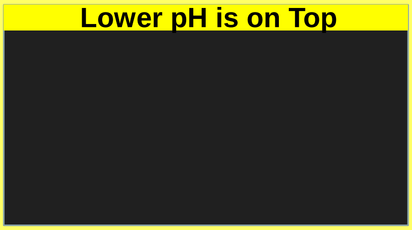
7” Sample “Blended” for pH Result

We Knew the Surface pH was Lower

Lower pH is on Top

7”

Sampl e depth



Why was it Lower pH on Top?

- Acidifying Surface Fertilizers
- Shallow Roots Exchanging H+
- Rainfall
- In the Clay Soils of WLEB-
  - pH INCREASES as you go deeper in the profile
- Lack of Inversion Tillage Maintains the Lower pH surface

What if?

- Surface 1 inch was in the 5.5 to 5.8 range 5 to 10 years ago? Very likely.
- With higher pH rainfall, especially the last 5 years, could our surface pH now average more like 6.2 to 6.3?
- Would this make P more soluble, like the chart indicates?
- Has aggressive liming the past 5 years due to high fertilizer prices contributed to this phenomenon?

This Theory Needs Investigated

- Presented at Heidelberg U.
- Several Interested
- Grants Applied for
- Ohio State Now has 2 Projects

What You Can Do

- Operate Under This Assumption:
  - –P is more soluble in (on) our soils than it used to be