Managing soybean iron deficiency chlorosis (IDC) with soil testing

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AGVISE Soil Fertility Seminar
March 14, 2018

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Wheat City Seeds
@Wheatcityseeds

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IDC Showing up in some soybean fields, not sure the variety, but can see where the water was

8:07 AM - 23 Jun 2017

Glenda Clezy
@geeclezy

Follow

Scouting soybean field with @aggrowconsult IDC sympomology@saskpulse

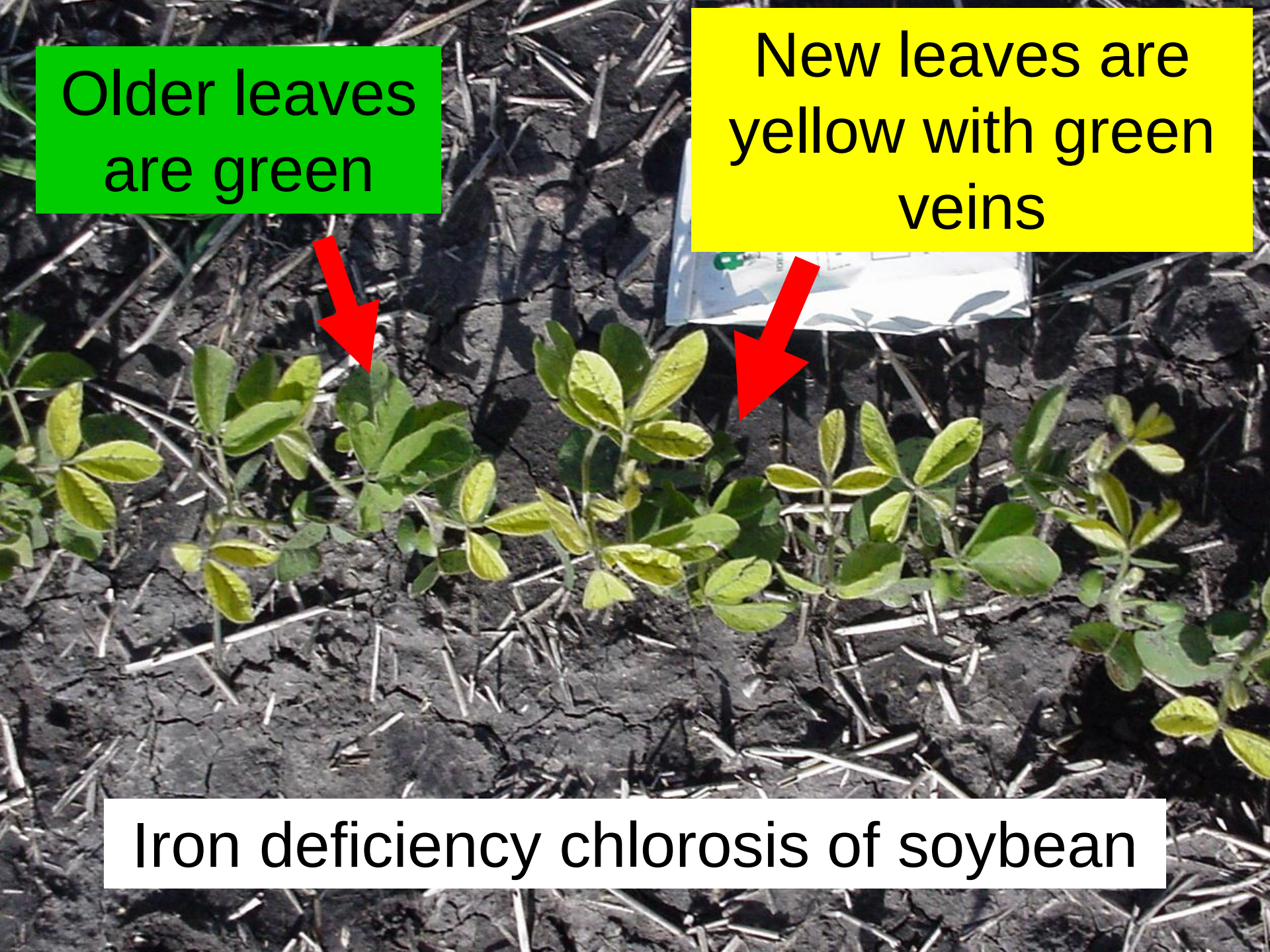
1:41 PM - 23 Jun 2017

Dane Froese
@dane_froese

Following

@MbPulseGrowers Saw some unusual soys today. Unifoliates green, trifoliates interveinally yellow. Only hdlnd affected. Any ideas? #scout17

4:40 PM - 16 Jun 2017

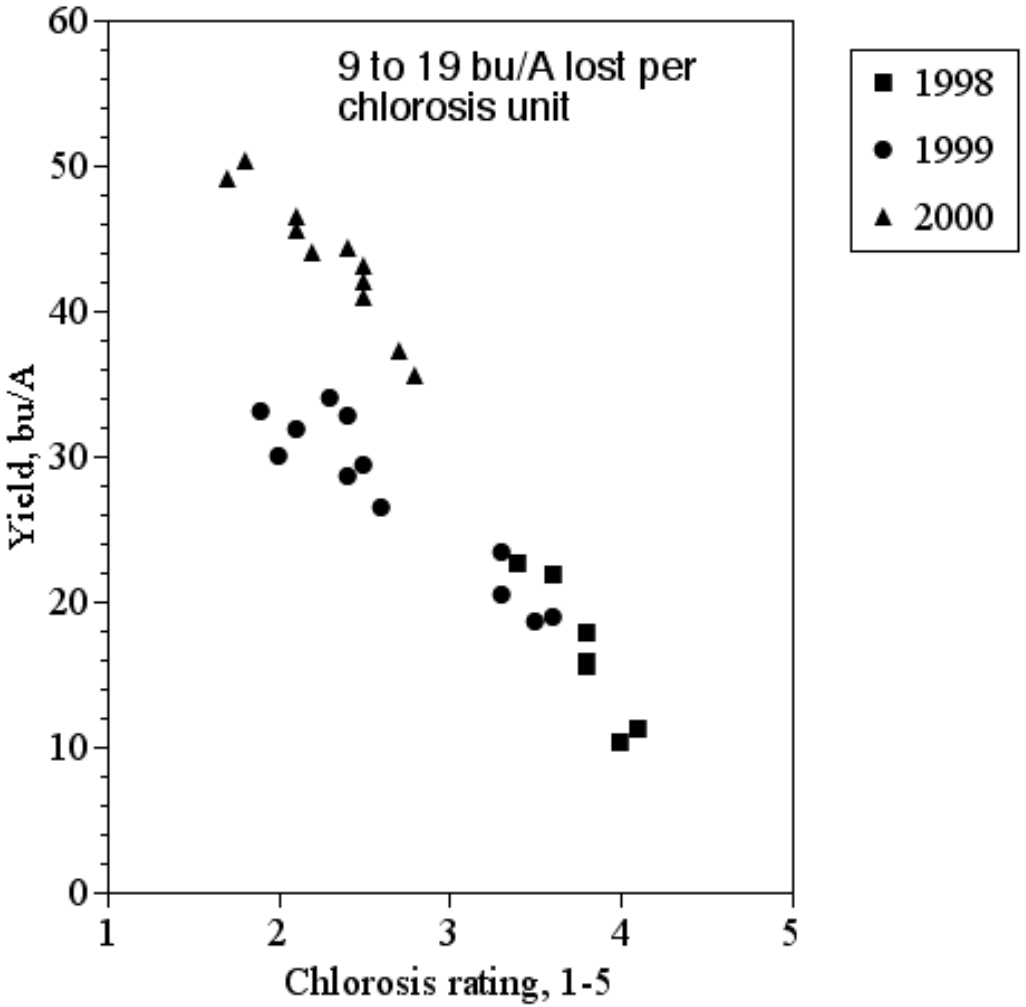


Iron deficiency chlorosis of soybean

Severe IDC persisting into 5-6 trifoliate stage greatly reduces yield

IDC rating scale

1. No chlorosis
2. Slight yellowing
3. Distinct interveinal chlorosis, no stunting
4. Stunting, some necrosis
5. Necrosis of upper leaves and growing point, dead plants



Franzen, D.W., and R.J. Goos. 2016. How much does IDC reduce soybean yield? NDSU Crop Pest Rep. 12 May 2016. North Dakota State Univ. Ext. Serv. https://www.ag.ndsu.edu/cpr/soils/how-much-does-idc-reduce-soybean-yield-05-12-16 (accessed 16 Feb. 2018).

Why is iron deficiency so bad in soybean?

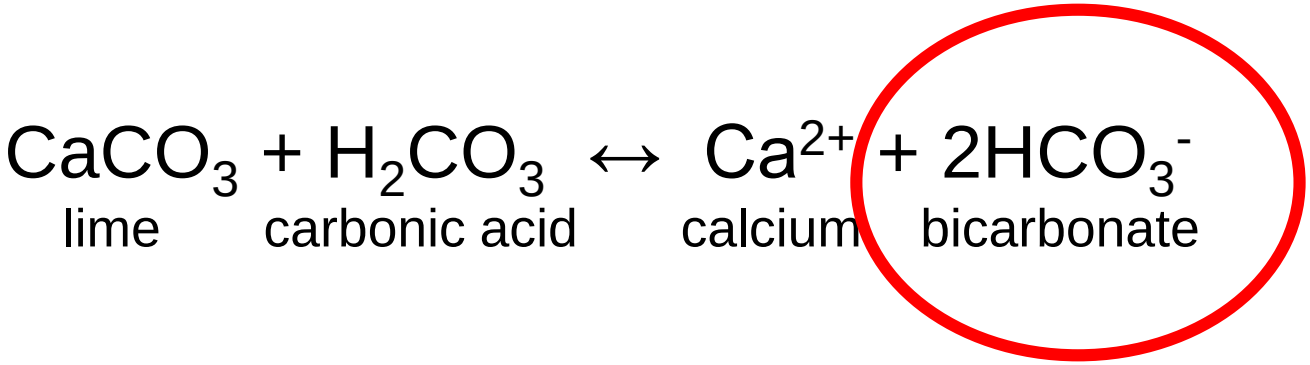
- Soil may contain over 450,000 lb Fe/acre
- Soybean plant only needs a few grams

Not a question of amount, but availability

- Soybean has really, really inefficient iron uptake
- Bicarbonate (HCO_3^-) dissolved in soil solution reduces iron availability

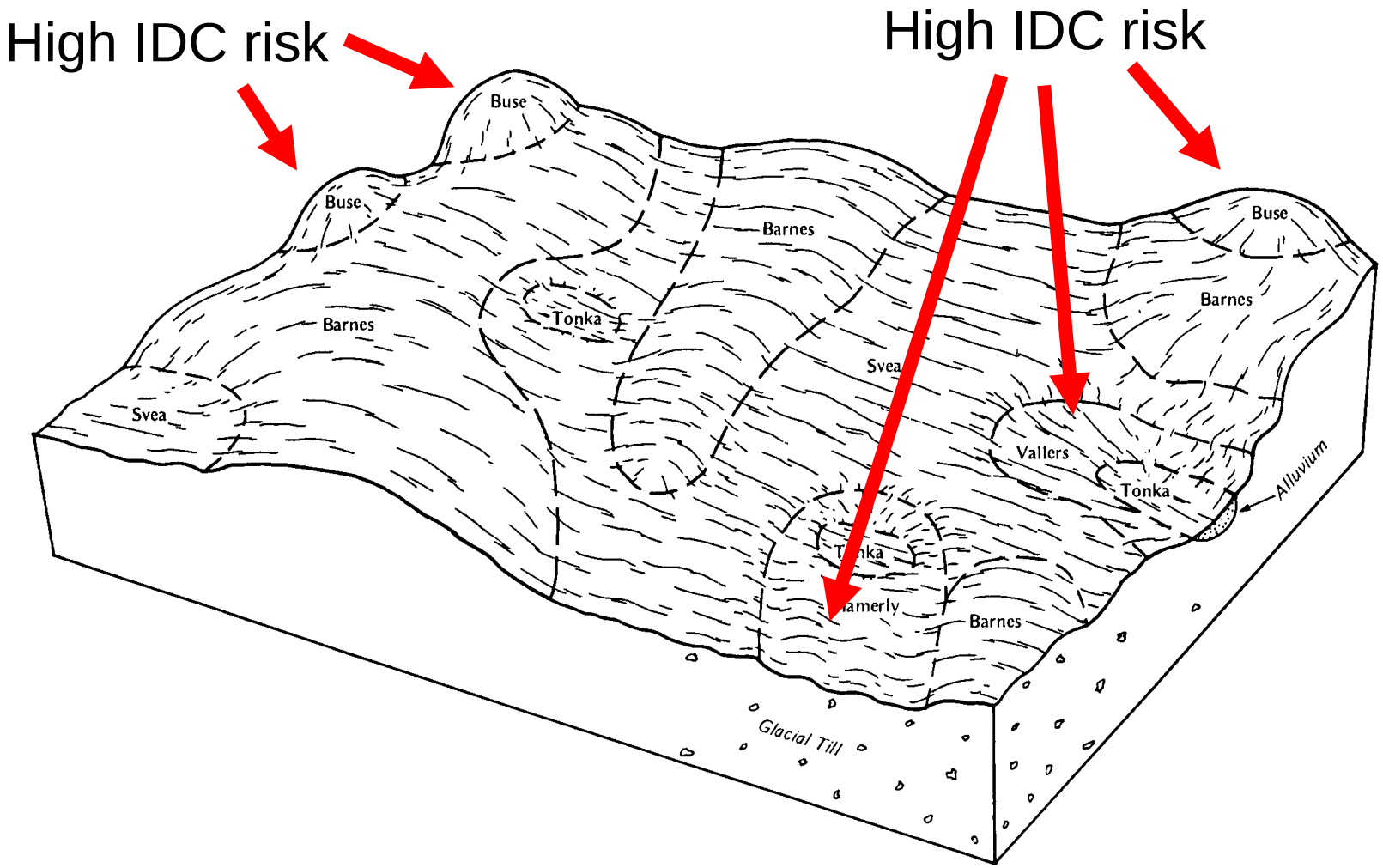
Lindsay, W.L. 1979. Chemical Equilibria in Soils. Blackburn Press, Caldwell, NJ.

Calcium carbonate (lime) reduces iron availability



<u>Bicarbonate neutralizes H^+</u> that the soybean root releases to make iron available

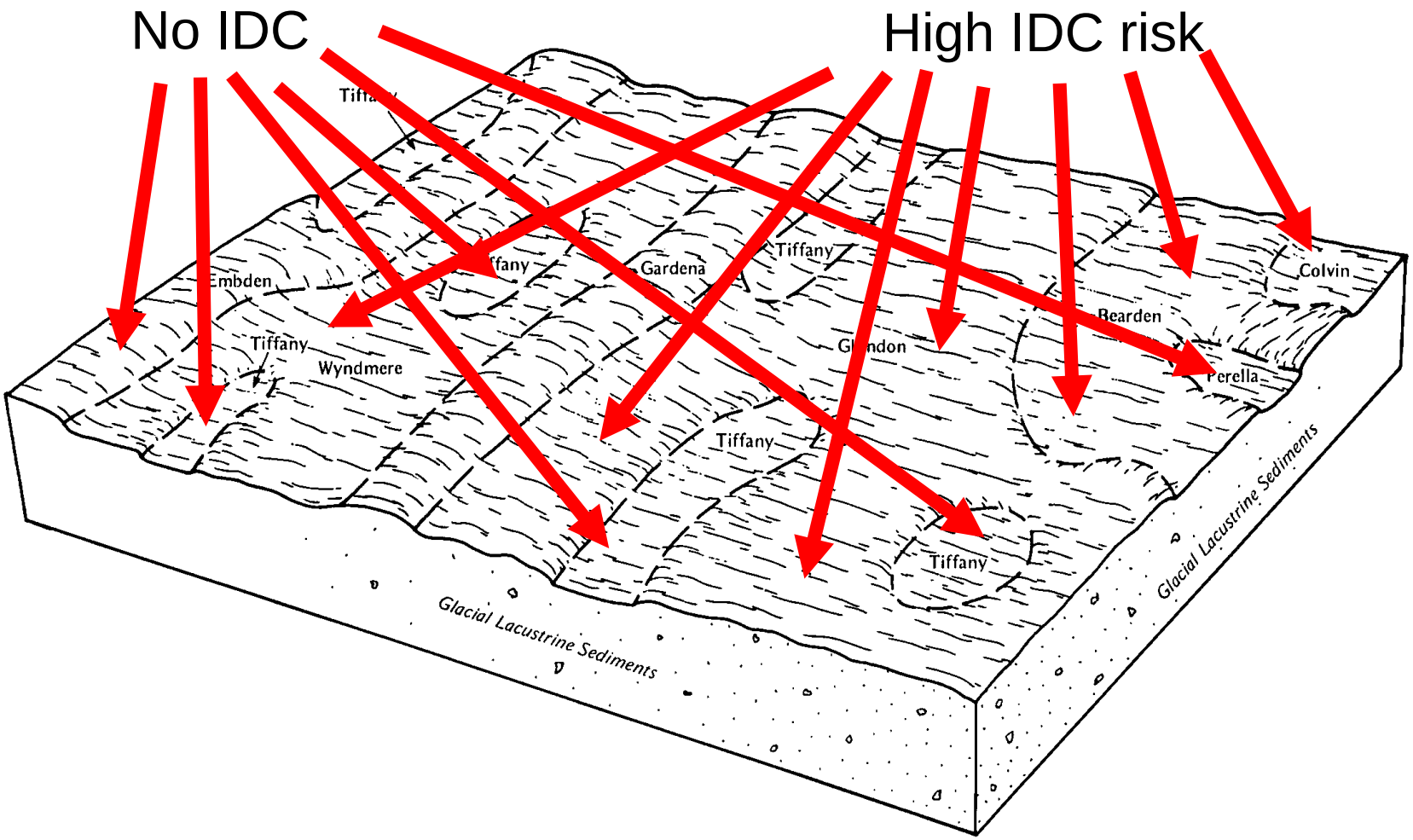
IDC on the glacial till landscape



Adapted from Goos, R.J. 2018. Iron deficiency chlorosis: Soil and plant answers to a festering problem. In: Endres, G. and Glogoza, P., chairs, 26th Advanced Crop Advisers Workshop, Fargo, ND. 13-14 Feb. 2018. North Dakota State Univ., Fargo, ND; Univ. Minnesota, St. Paul, MN.


On the rolling till plain:
High carbonate and salinity
around closed depressions

IDC on the glacial lake plain



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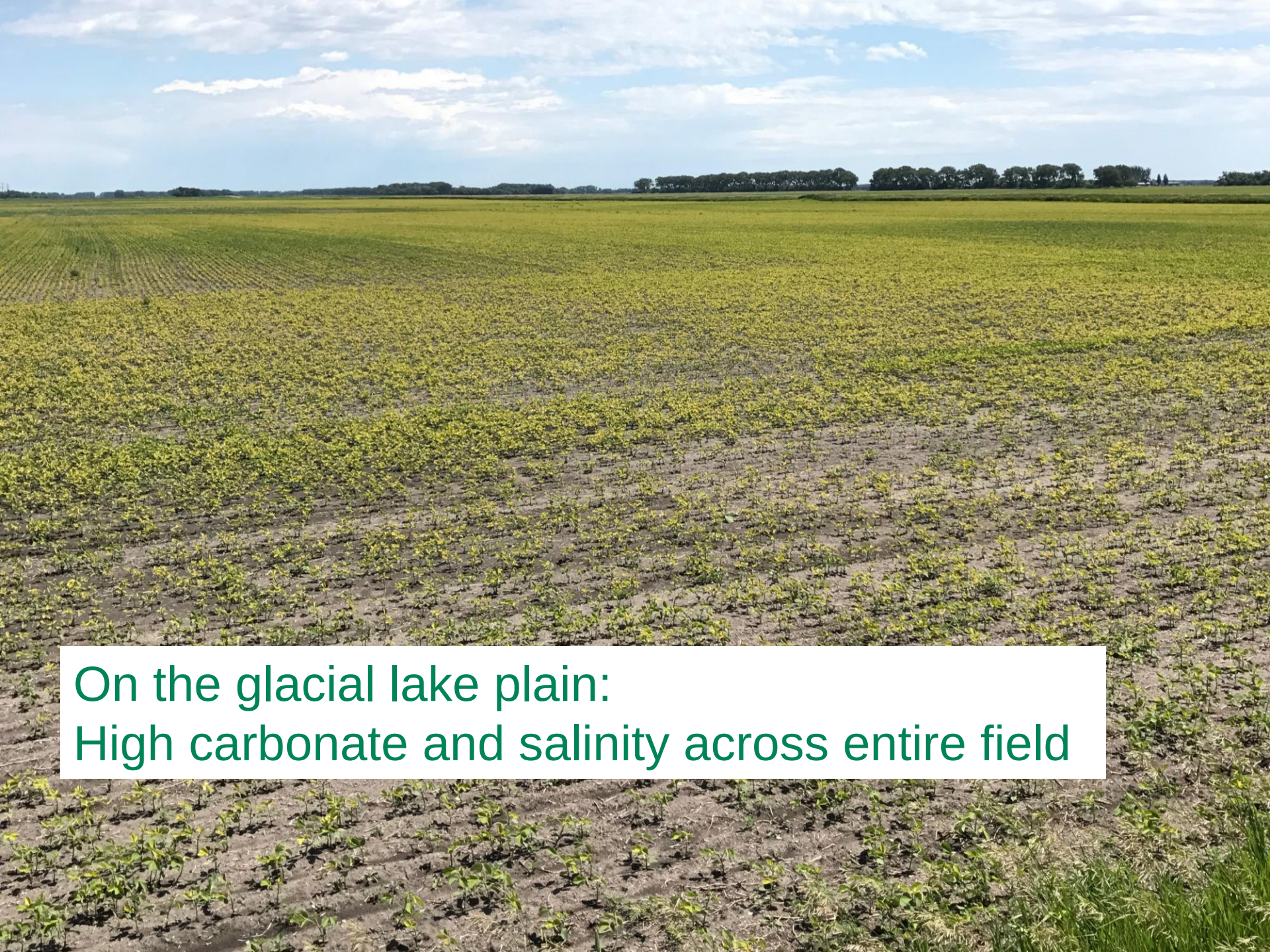
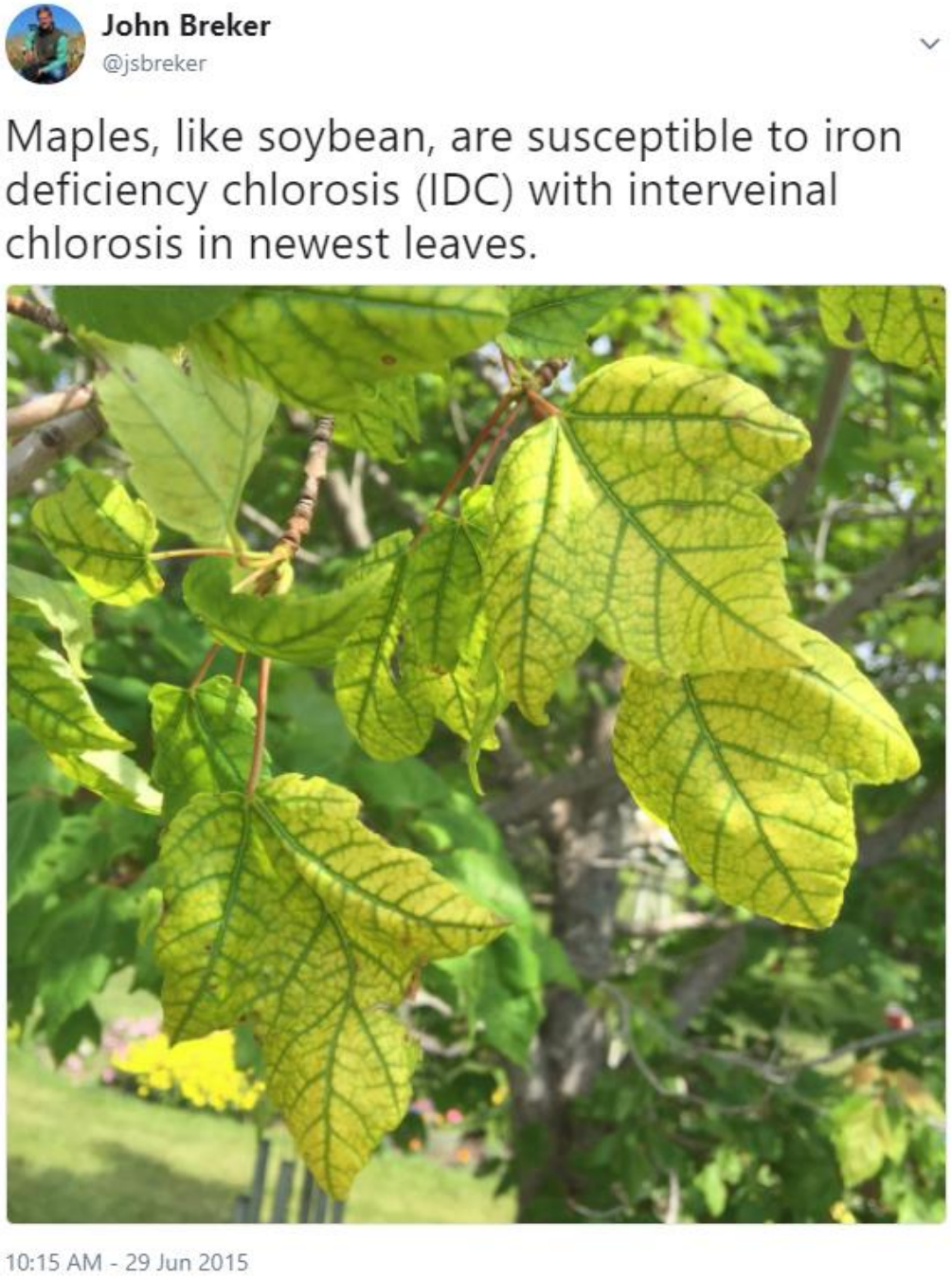

On the glacial lake plain:
High carbonate and salinity across entire field

Many plant species that evolved in acidic environments are IDC susceptible

- Maples
- Pin oak
- *Azalea*
- *Rhododendron*
- Rugosa rose



Soil factors contributing to soybean IDC

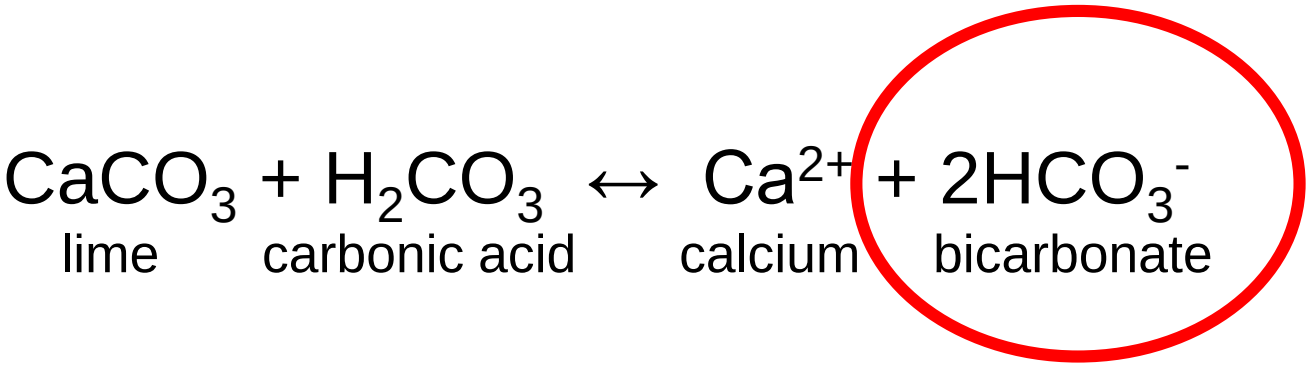
The short list

- Carbonate (CCE)
- High soil water content
- Cool soil temperature
- Salinity
- High residual nitrate
- High pH???

Soil factors contributing to soybean IDC

Carbonate (calcium carbonate, lime, CCE)

- Central Corn Belt: 0-5% CCE
- Northern Plains: 0-30% CCE



Soil pH > 7.3 may have carbonate (test needed)

Soil pH < 7.3 likely no carbonate

Soil factors contributing to soybean IDC

Salinity (electrical conductivity, soluble salts)

- Reduced root growth
- Reduced water uptake
- Competing nutrient effects

Residual nitrate (NO_3^-)

- Increased bicarbonate (HCO_3^-) in rhizosphere
- Affects internal Fe metabolism

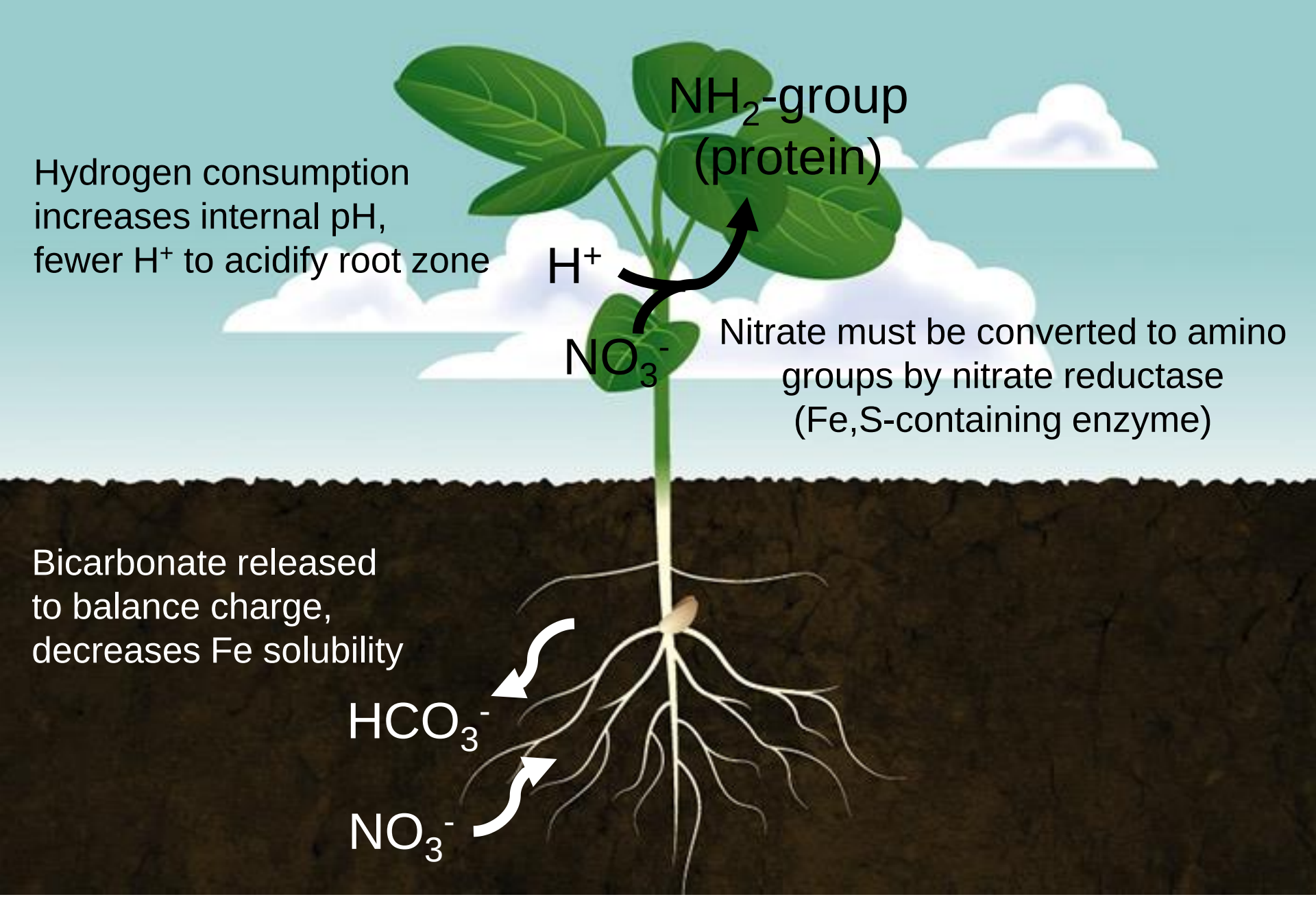


Image from http://www.syngenta-us.com/thrive/news/root-health-tools.html

Mengel, K., and E.A. Kirkby. 2001. Principles of Plant Nutrition. 5th ed. Kluwer Academic Publishers, Dordrecht, The Netherlands.

Soil factors contributing to soybean IDC

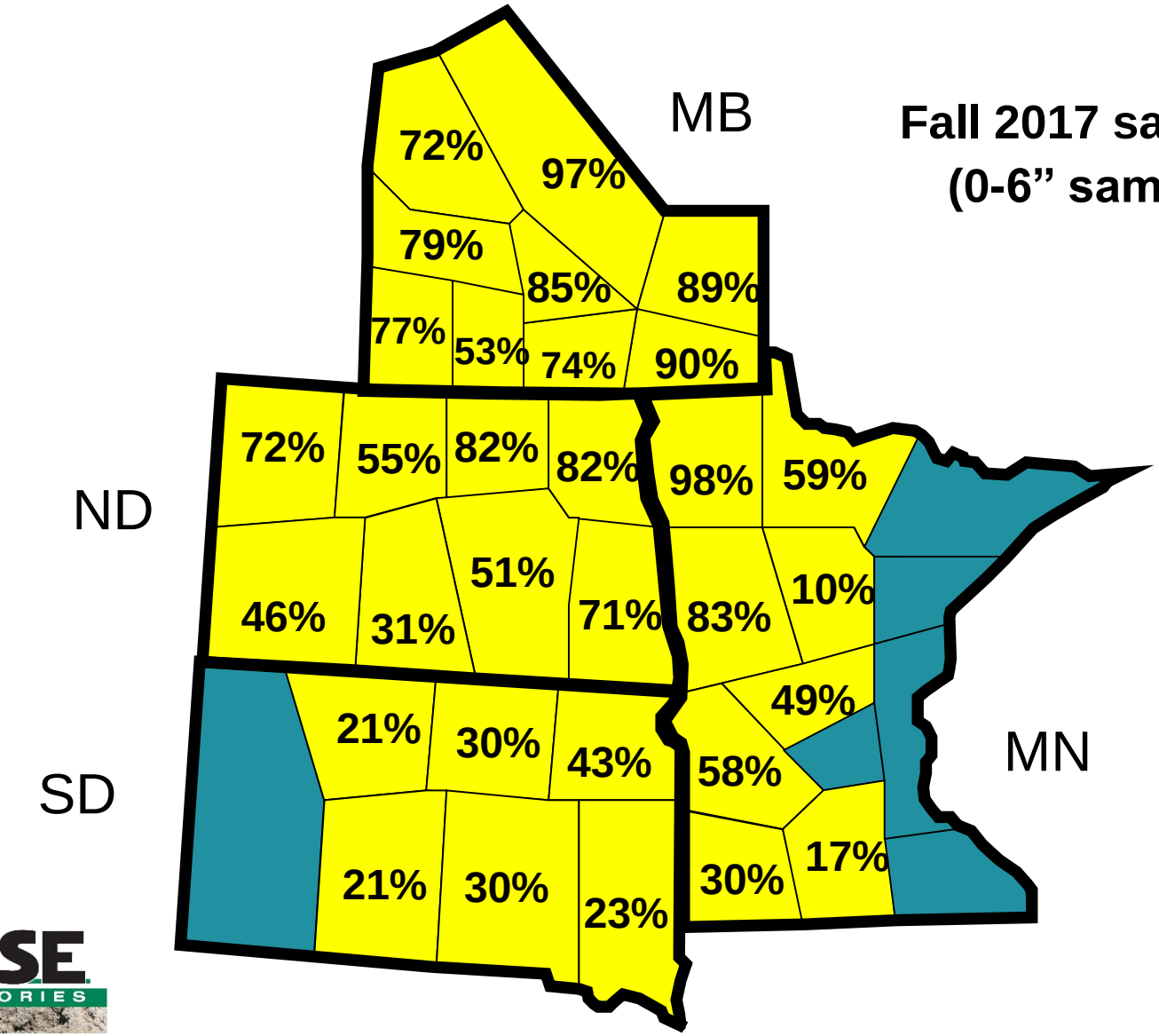
Cool soil temperature

- Reduced root activity
- Dissolves more $CO_2 \rightarrow HCO_3^-$

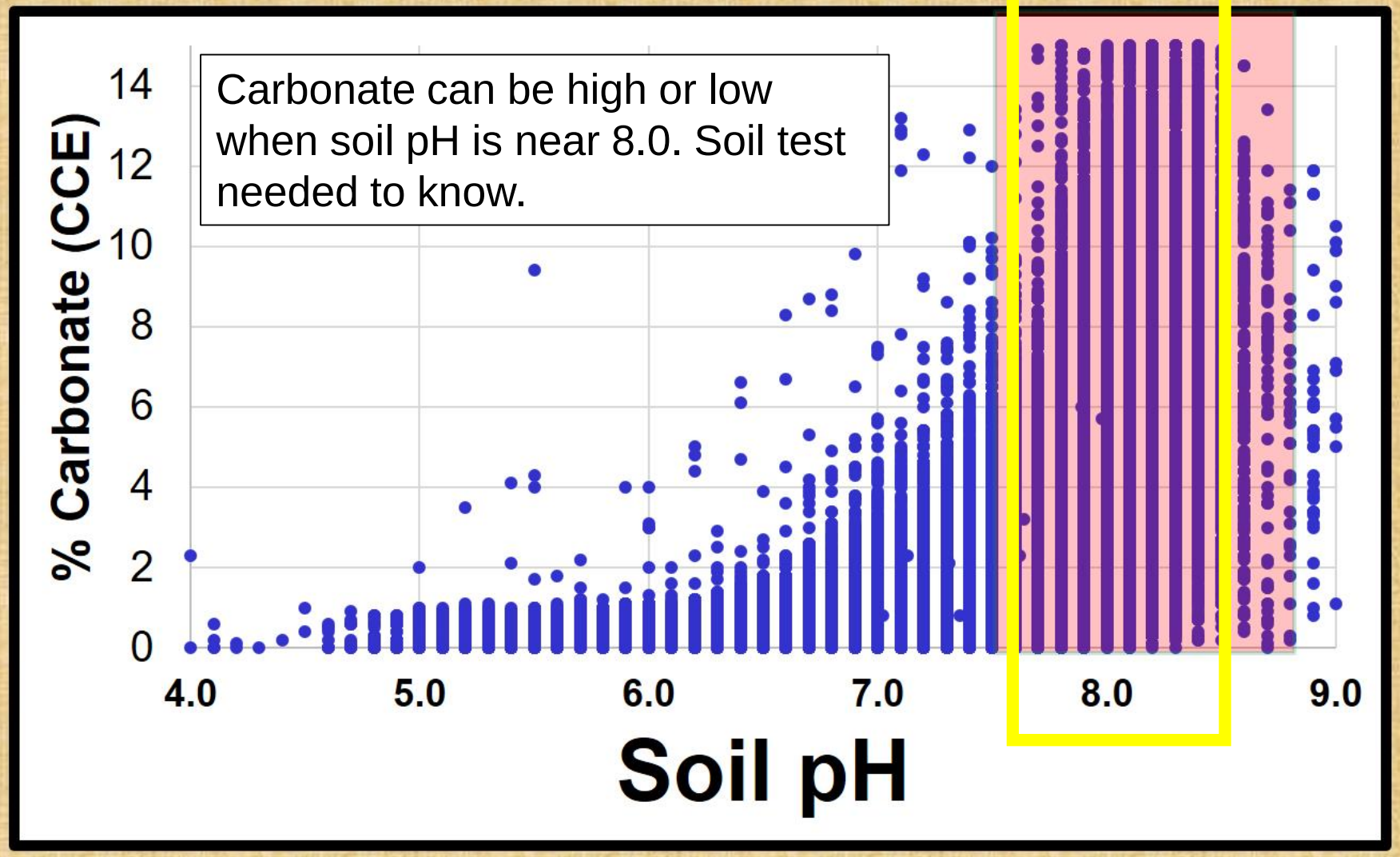
High soil water content

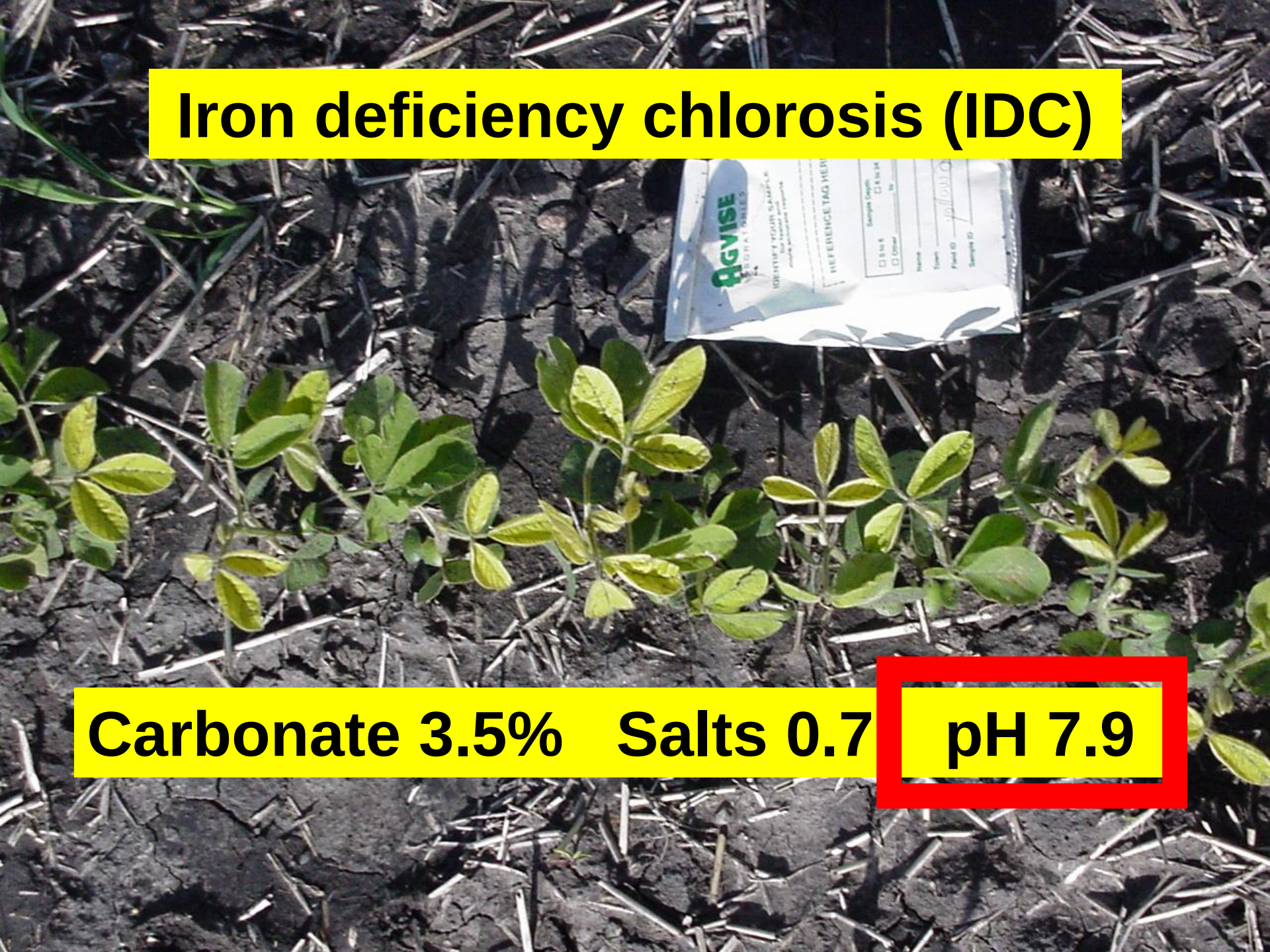
- Reduced gas exchange (more $CO_2 \rightarrow HCO_3^-$)
- Dissolves more $CO_2 \rightarrow HCO_3^-$
- Reduced root development
- Decreased nutrient uptake

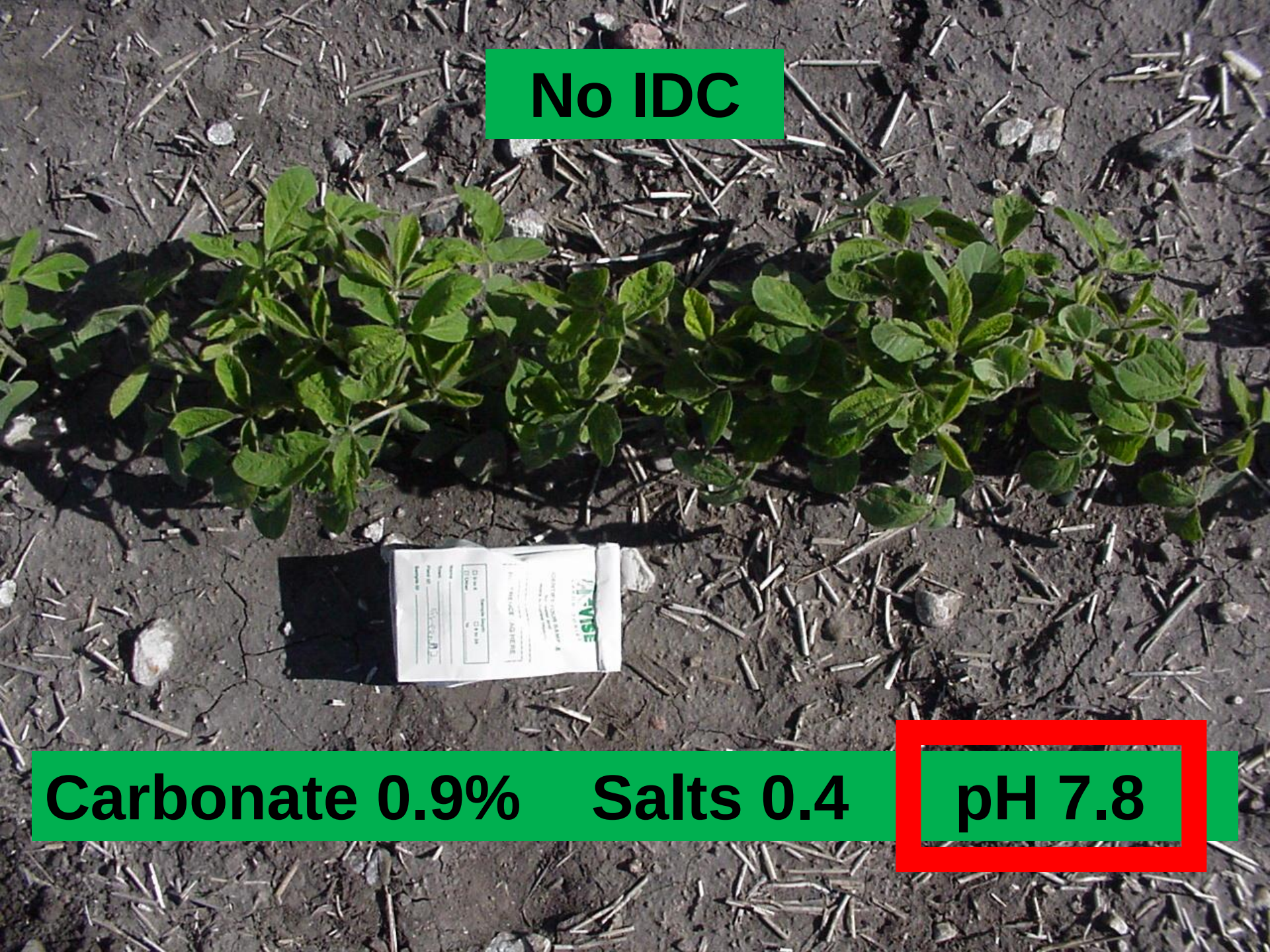
Soil samples with soil pH greater than 7.3



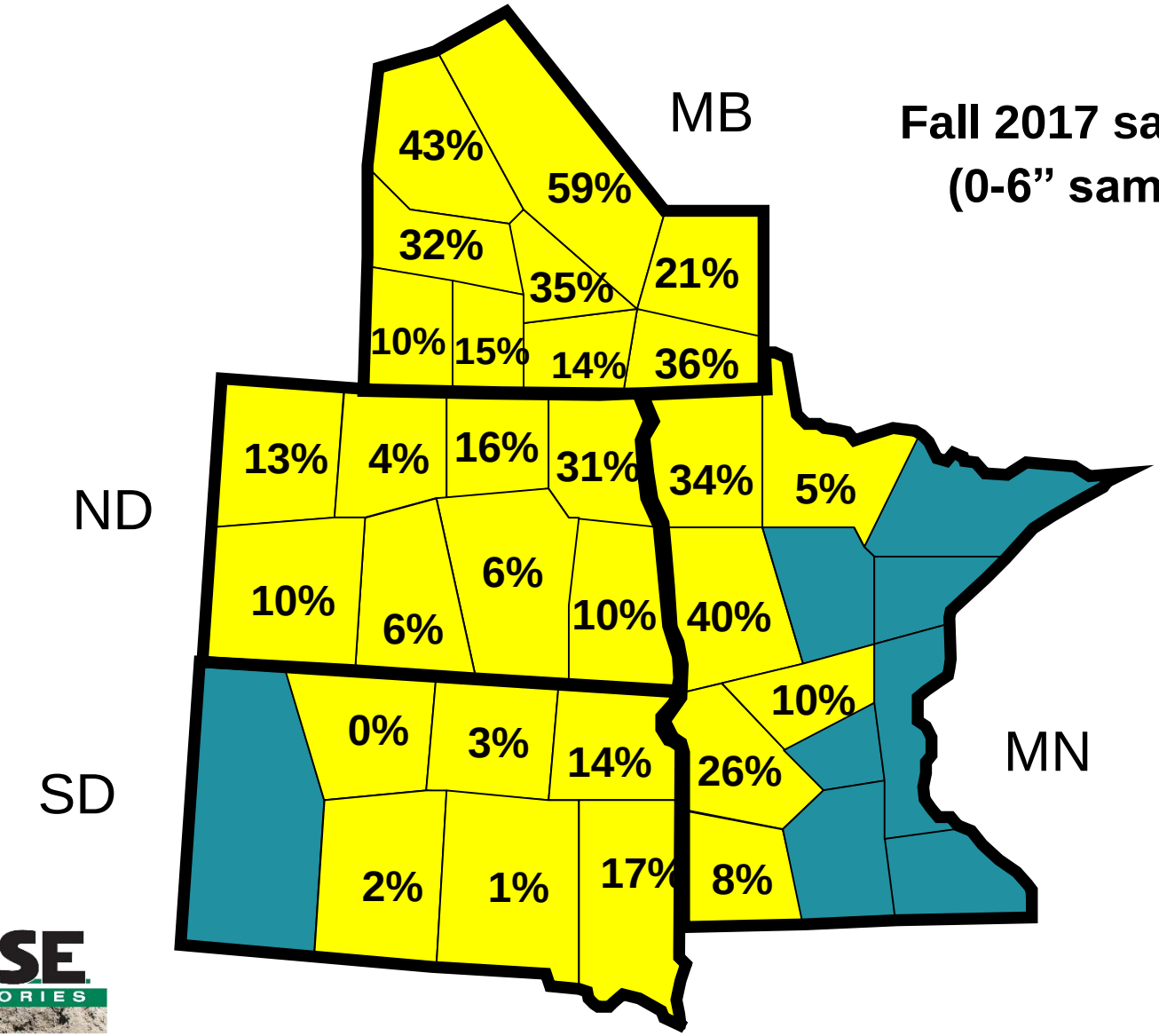
Soil pH and Soil Carbonate - 2017



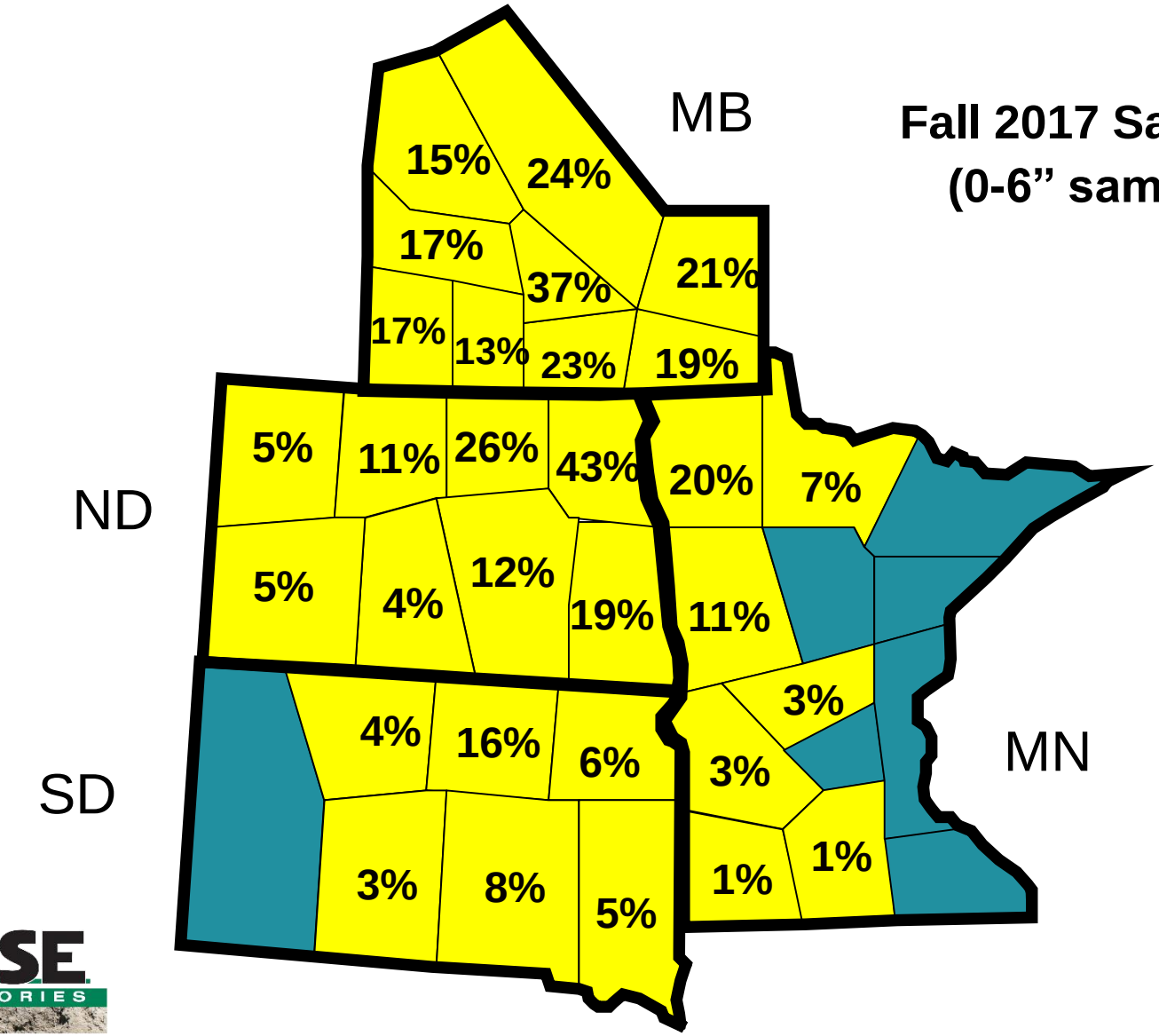

Iron deficiency chlorosis (IDC)
AGVISE
Carbonate 3.5%
Salts 0.7
pH 7.9


No IDC
Carbonate 0.9%
Salts 0.4
pH 7.8

Soil samples with carbonate greater than 5.0%



Soil samples with salts greater than 1.0 dS/m



AGVISE –Soybean IDC risk index

Based on observations and soil samples from 103 fields (2001)

Calcium carbonate (CCE)	Electrical conductivity (EC)	Relative IDC risk
%	dS/m (1:1)	
<2.5	<0.5	Low
<2.5	0.5 – 1.0	Moderate
<2.5	>1.0	Very High
2.6-5.0	<0.25	Low
2.6-5.0	0.26-0.50	Moderate
2.6-5.0	0.51-1.0	High
2.6-5.0	>1.0	Very High
>5.0	<0.25	Moderate
>5.0	.26-0.50	High
>5.0	0.51-1.0	Very High
>5.0	>1.0	Extreme

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Foundational research from Franzen, D.W., and J.L. Richardson. 2000. Soil factors affecting iron chlorosis of soybean in the Red River Valley of North Dakota and Minnesota. J. Plant Nutr. 23(1):67–78.

TABLE 1. FIELD RISK OF IDC BASED ON CARBONATE AND SOLUBLE SALT SOIL TEST LEVELS

SOLUBLE SALTS	CARBONATE LEVEL (%)		
(mmhos/cm)	0 to 2.5	2.6 to 5	>5.0
0 to 0.25	Low	Low	Moderate
0.26 to 0.50	Low	Moderate	High
0.50 to 1.0	Moderate	High	Very high
>1.0	High	Very high	Extreme

Heard J., J. Lee and R. Tone. 2013. *Nitrogen and soybeans: friends, foes or just wasted fertility?* Proc. Manitoba Agronomists Conference.

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Managing IDC with soil testing

Identify fields with low IDC risk

- Soil test for carbonates and salinity
- Choose low IDC risk fields for soybean

Mitigating moderate to high IDC risk

1. Variety selection
2. Variety selection
3. Variety selection
4. Wider rows (plant closer together reduces IDC)
5. Apply high quality FeEDDHA with seed
6. Plant companion cereal with soybean (uses excess water and nitrate)

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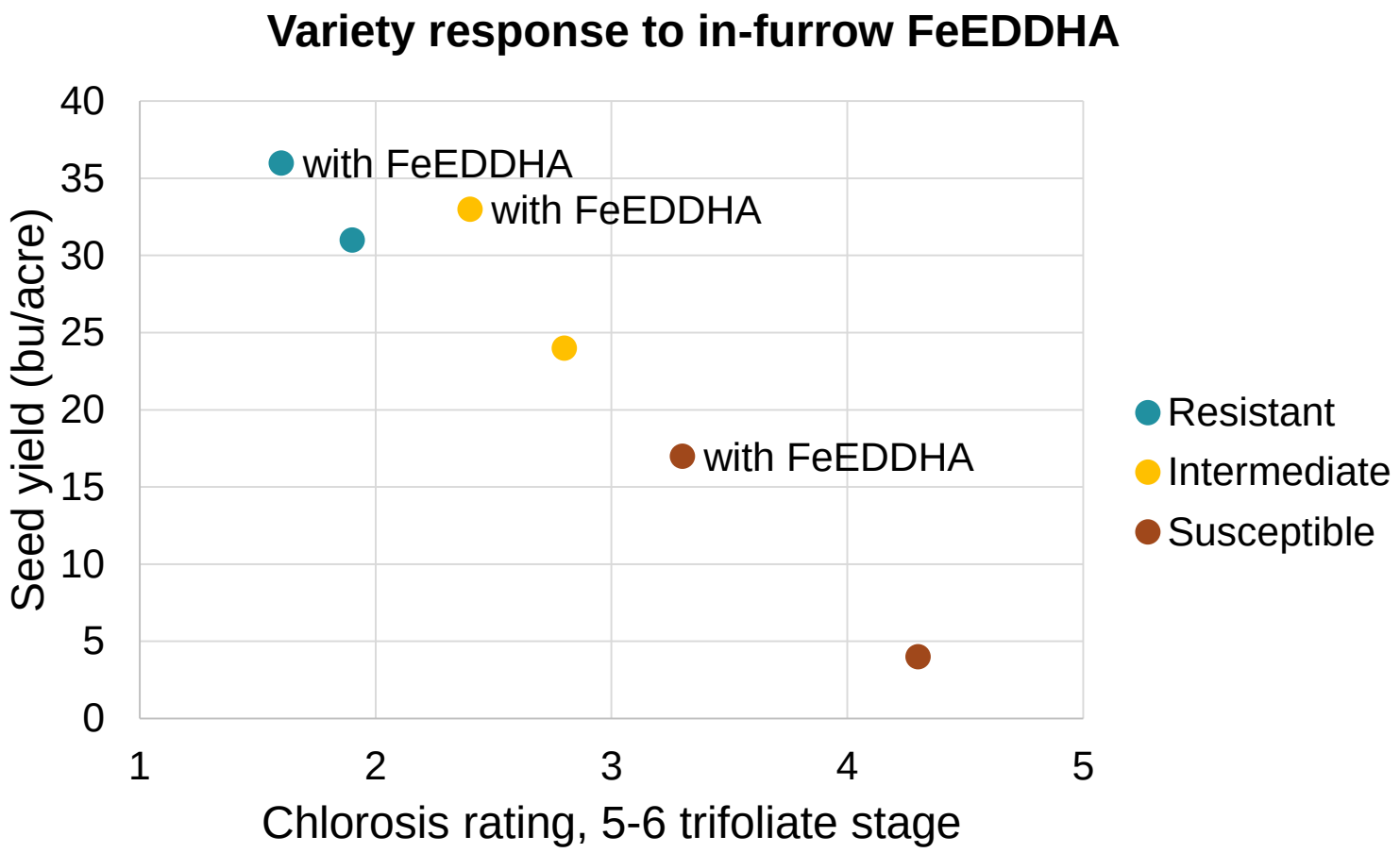
You cannot turn a weak variety into a strong variety



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Goos, R.J., and B.E. Johnson. 2000. A comparison of three methods for reducing iron-deficiency chlorosis in soybean. Agron. J. 92(6):1135–1139.

Quality matters

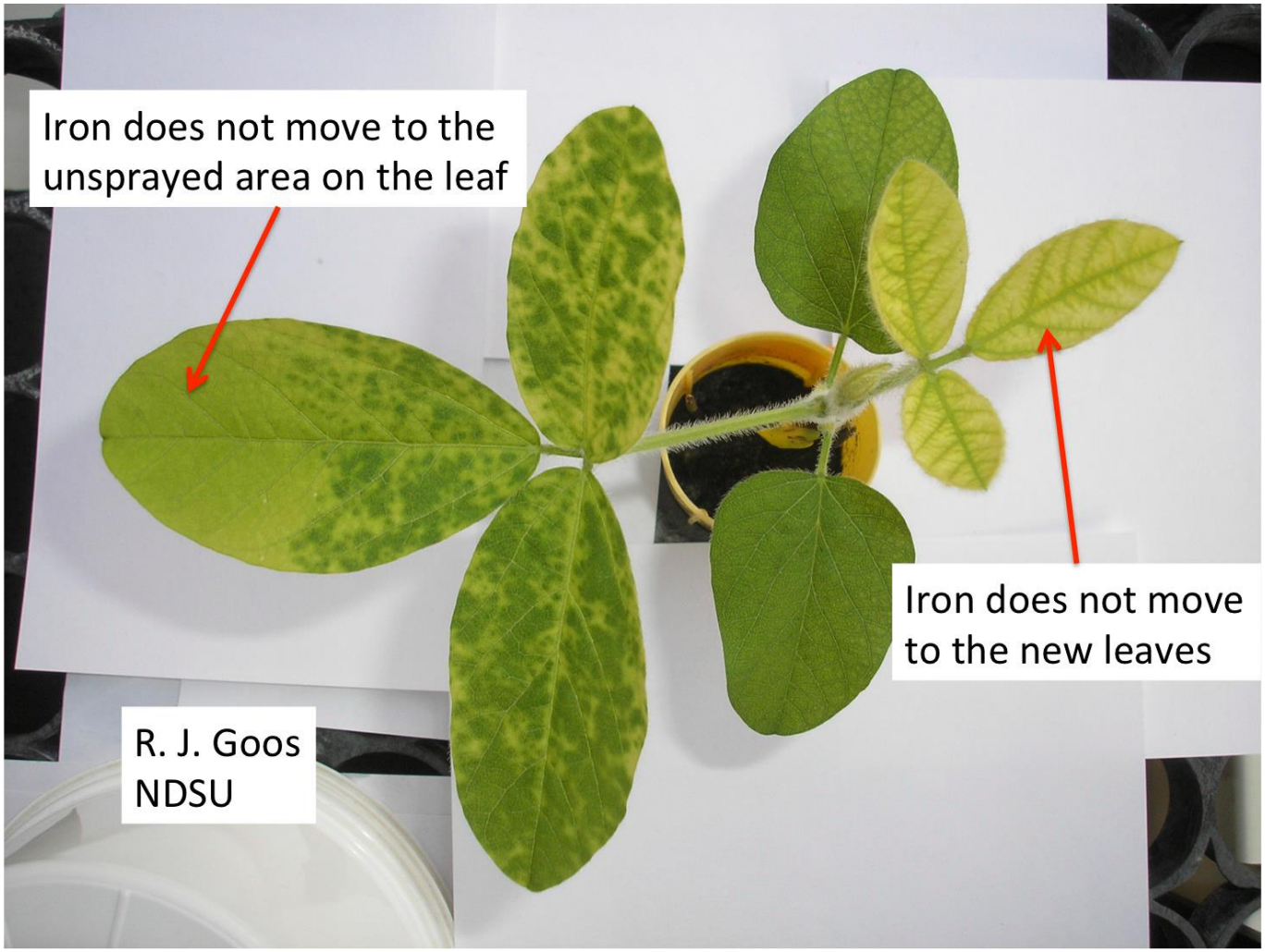
Chlorosis ratings

- Seed companies vary greatly, scoring and rigor
- Local trials, neighbor experience, maybe not newest variety
- NDSU soybean IDC variety trials

Iron fertilizer (FeEDDHA)

- Chelate quality (*ortho-ortho* EDDHA content) varies considerably

Foliar Fe not effective for rescue



Goos, R.J. 2017. Options limited for rescue treatments for IDC in soybeans. NDSU Crop Pest Rep. 22 June 2017. North Dakota State Univ. Ext. Serv. https://www.ag.ndsu.edu/cpr/soils/options-limited-for-rescue-treatments-for-idc-in-soybeans-06-22-17 (accessed 16 Feb. 2018).

Managing IDC with soil testing

1. Identify fields with low IDC risk
   - Soil test for carbonates and salinity
   - Yes…some fields may not be suitable for soybean

2. Make maps of previous IDC hotspots
   - Aerial or satellite imagery
   - Site-specific mitigation strategies?

3. Choose IDC-resistant varieties, wider rows, FeEDDHA, companion cereal

Tillage influence on IDC?

Chisel plow

Strip-till

Factors: carbonate uplift, soil water evaporation, salt movement, soil structure, gas exchange (carbon dioxide), nitrogen mineralization?

A.F. Wick, North Dakota State Univ. (personal communication, 2017)

Thank you for your kind attention

Questions?

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