

**Soil Fertility Considerations for
Small Grains and Soybeans
Following a Wet Fall
Best of the Best, Minot, 2020**

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Spring wheat-

- Recommendations not yield-based**
 - Surface urea should be NBPT treated**
 - Starter P is important**
 - Chloride of minor importance**
 - Micronutrients not important**
- unless you farm where soil OM is >10%**

Welcome to the North Dakota Wheat Nitrogen Calculator

You will need to know the location of the farm, the general productivity of the soils, the price you contract for wheat, the cost per pound of N, the soil test nitrate-N to a depth of 2-feet, and the previous crop.

Please select the location of the farm. The map of North Dakota on this site will help you determine the region of the farm. *Click on the map for a detailed view.*



- Eastern North Dakota
- Western North Dakota
- Langdon Region

1

Low productivity is defined in Eastern ND as historical yields below 40 bushels per acre

Medium productivity is defined in Eastern ND as historical yields from 41 to 60 bushels per acre

High productivity is defined in Eastern ND as historical yields over 60 bushels per acre

Please select the historical productivity of the farm from the options below.

- Low Productivity
- Medium Productivity
- High Productivity

2

Select Nearest Wheat Price
(\$/bushel)

\$5.00

Please indicate the crop previously planted in the field.

- No Nitrogen-supplying crop
- Soybean, Field Pea, Dry Bean, Lentil, Chickpea, or harvested Sweet Pea
- Sugarbeet with yellow-green leaves
- Sugarbeet with green leaves
- Harvested Alfalfa or unharvested Sweet Clover (> 5 plants/sq-ft)
- Harvested Alfalfa or unharvested Sweet Clover (3-4 plants/sq-ft)
- Harvested Alfalfa or unharvested Sweet Clover (1-2 plants/sq-ft)
- Harvested Alfalfa or unharvested Sweet Clover (< 1 plants/sq-ft)

Nitrogen provided by previous crops:

0

Please indicate the previous tilling method used in the field.

Low Productivity
 Medium Productivity
 High Productivity

Select Nearest Wheat Price (\$/bushel)

3

Select Nearest N Cost (cents/lb)

4

Nitrogen Recommendation Before Credits:

Please indicate the amount of nitrates in the soil. (Enter the analysis result in the box.)

Soil test for Nitrogen analysis (lbs/acre 2-ft depth) Input OK

5

Sugarbeet with green leaves
 Harvested Alfalfa or unharvested Sweet Clover (> 5 plants/sq-ft)
 Harvested Alfalfa or unharvested Sweet Clover (3-4 plants/sq-ft)
 Harvested Alfalfa or unharvested Sweet Clover (1-2 plants/sq-ft)
 Harvested Alfalfa or unharvested Sweet Clover (< 1 plants/sq-ft)

6

Nitrogen provided by previous crops:

Please indicate the previous tilling method used in the field.

Is the field/area conventionally tilled (chisel and/or disc, and/or field cultivator or plow)?
 Has the field/area been in No-till for 1 to 5 years?
 Has the field/area been in No-till for more than 5 years?

7

Nitrogen recommendations assume conventional tillage and no adjustment in N rates are made.

Please indicate the percent of organic matter in the soil. (Enter the percentage in the box.) (If soil organic matter exceeds 5.9%, please type in the soil organic matter value. If 5.9% or less, please leave blank.)

Organic matter % Input OK

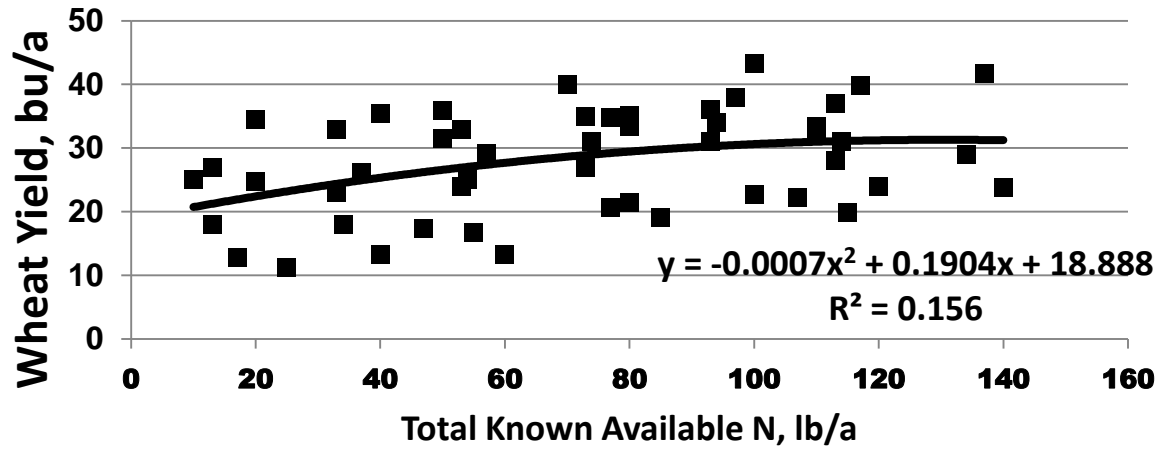
8

Input OK

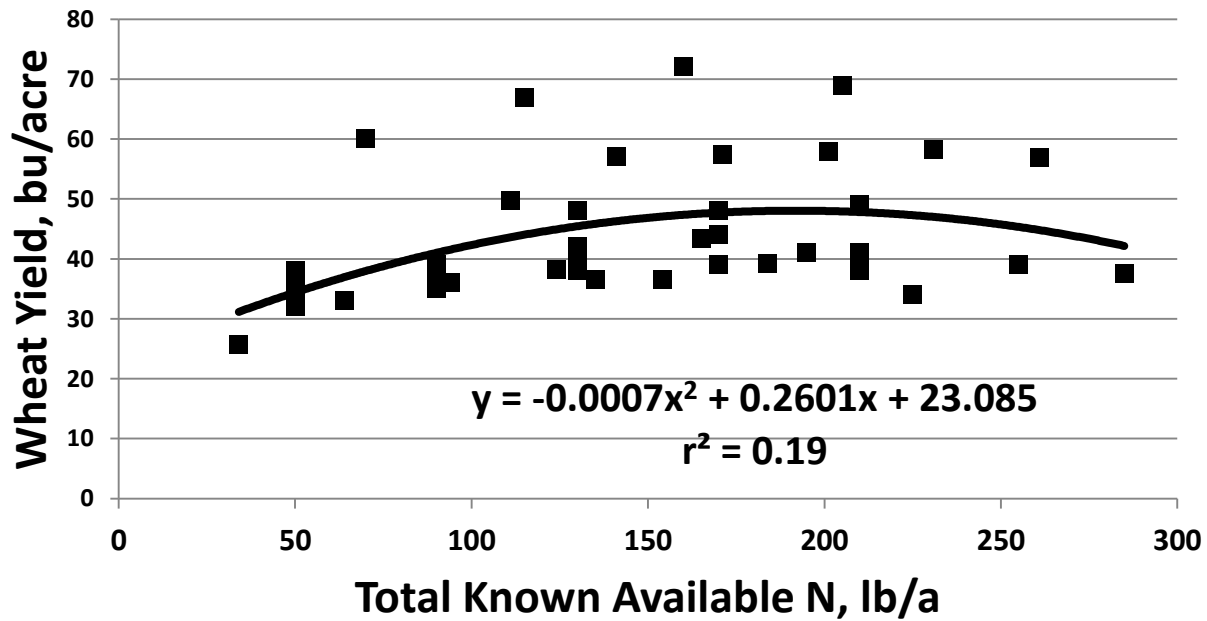
Nitrogen recommendation: plus/minus 30 lbs. N

The final Nitrogen recommendation is the average optimal rate. Growers may choose to apply up to 30 lb N/acre more or less than the calculated N rates due to protein traits of a variety, special soil conditions such as susceptibility to spring denitrification, application techniques that may not be most efficient or historical experiences from the field or part of a field that may influence N uptake and efficiency. For wheat after small grains, we assume about 2,000 lb/acre of straw residue. For every 2,000 lb/acre straw greater than this, add 30 lb N/acre.

West Wheat Yield Under Conventional Tillage

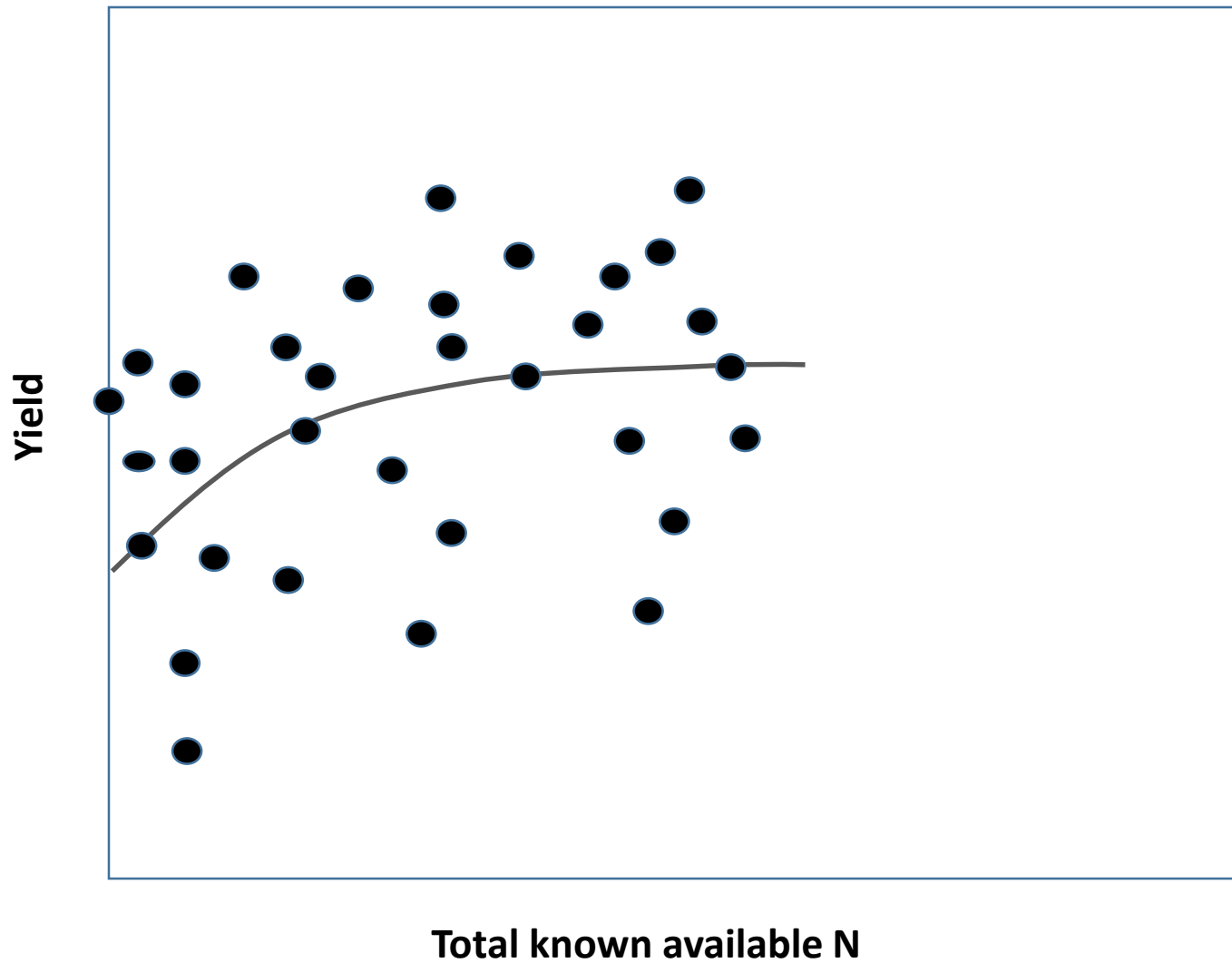


West Wheat Yield Under Long-term No-Till



Why is the aggregated relationship of yield and available N so 'diffuse', when the relationships within sites are so highly related?

Combining all sites with actual yield at N rate looks like this



To get a better idea of what the data look like without showing all the curves is to 'Standardize' the data- putting it all in the same scale

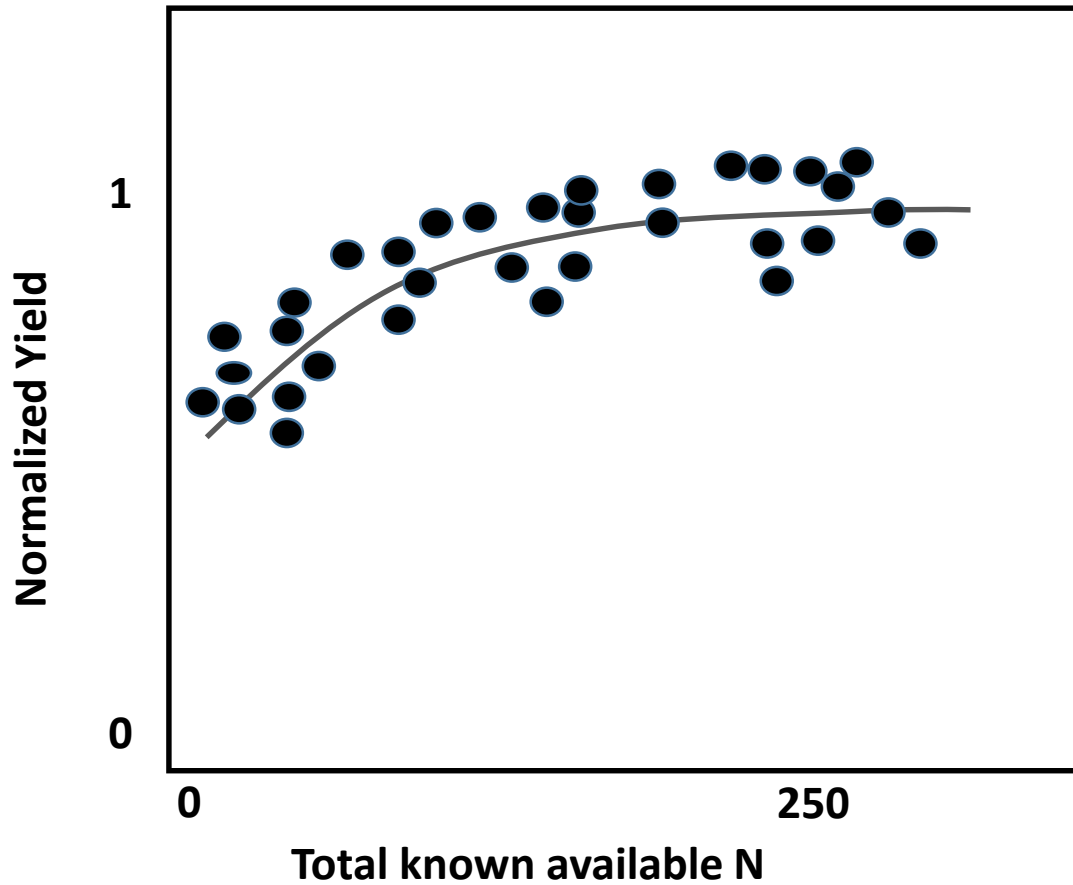
For example-

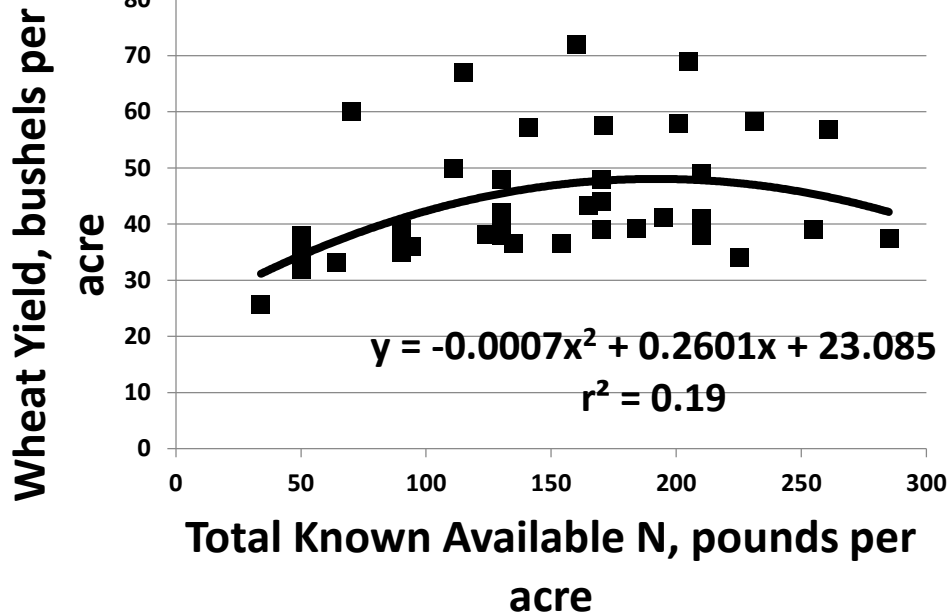
A wheat site with high yield 80 bu/acre, divide all yields by 80, and we end up with values from 0 to 1

A wheat site with high yield 40 bu/acre, divide all yields by 40, and we end up with values from 0 to 1

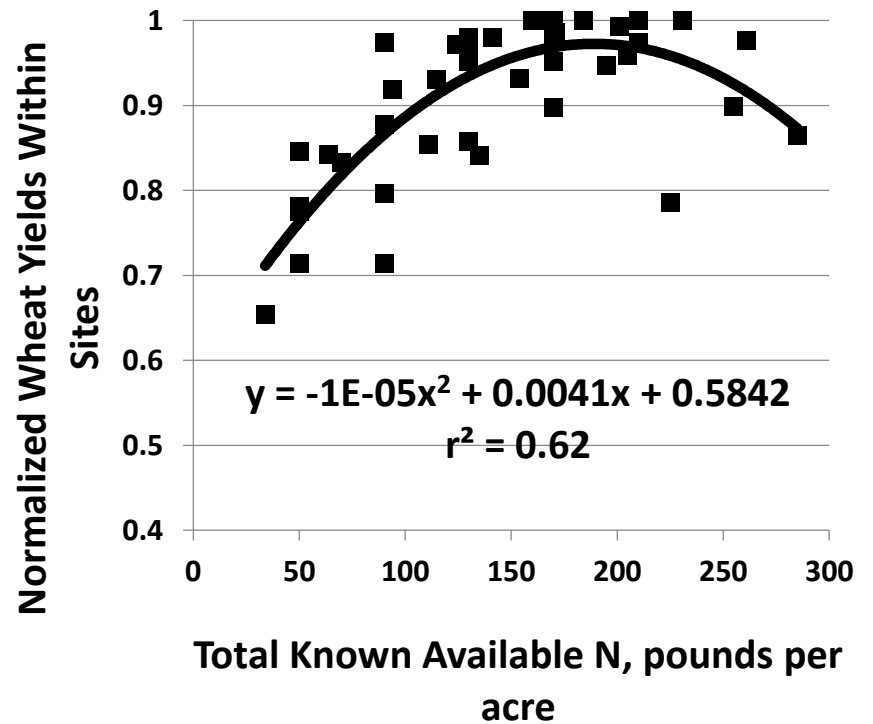
A wheat site with high yield 60 bu/acre, divide all yields by 60, and we end up with values from 0 to 1

Normalizing yields at all sites ends up looking like this-





Western ND No-Till wheat sites normalized yields



Low yield environment-
usually drier (sometimes excessive wetness)
Lower N use efficiency and crop uptake
Less N mineralization

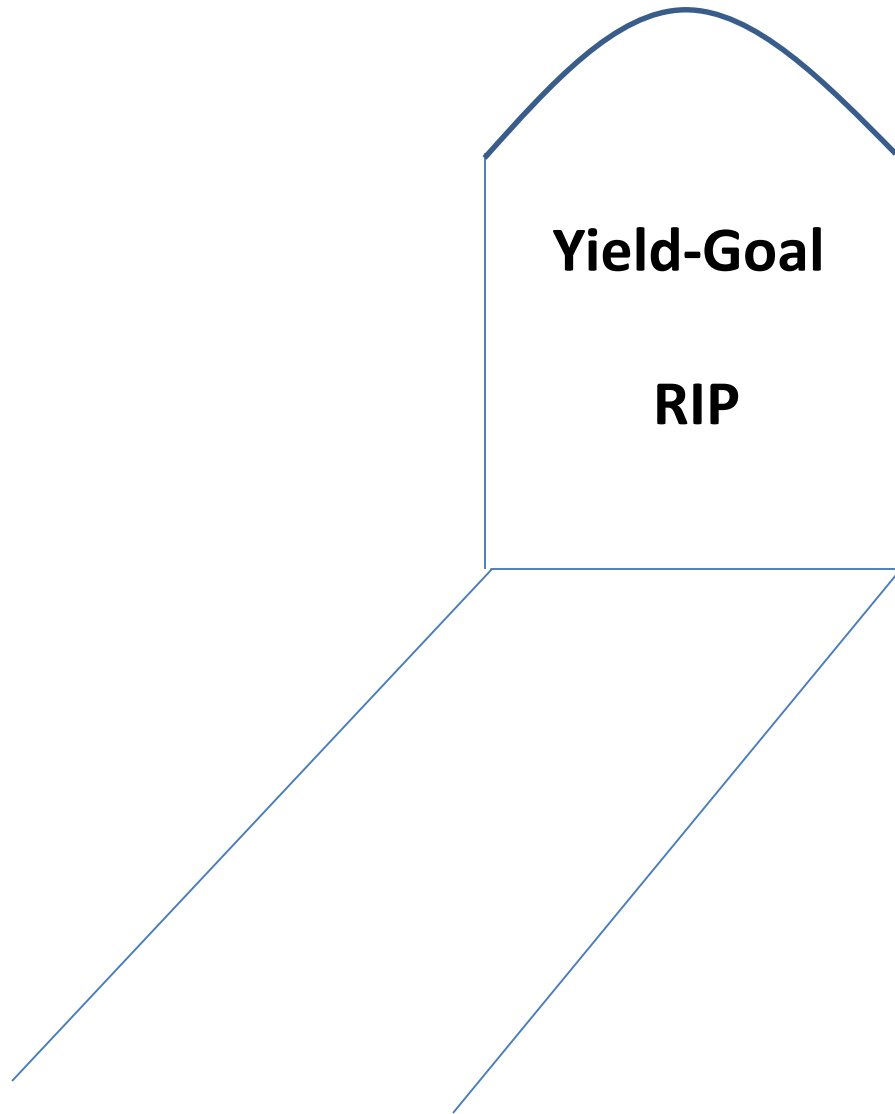
High yield environment-
Moisture near ideal- not too wet or too dry
Higher N use efficiency and crop uptake
Greater N mineralization

**Net result is that rate to produce economic max yield
is similar in both environments.**

There is an app for Android and iPhones for the 3 N calculators, including wheat.

Go to app store and search for North Dakota Crop Nitrogen Calculator follow the instructions.

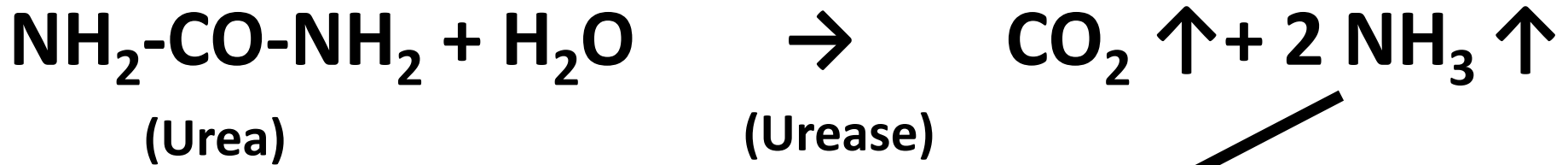
It's free to download.



Yield-Goal

RIP

Urea is subject to ammonia volatilization if placed on or near the surface.



pH > 7 drives NH₃ towards gas

pH < 7 drives NH₃ to NH₄⁺

Yield for side-dressed no-till corn in Hardin County, KY. (From Schwab and Murdock, 2009)

Treatment	Yield, bushels per acre
Check (50 lb N/acre preplant N only)	117 d*
Urea	158 c
Urea + Agrotain	201 b
SuperU	201 b
UAN	150 c
UAN + Agrotain	179 bc
UAN + Agrotain Plus	175 bc
Ammonium nitrate	239 a

Ammonia volatilization from surface and incorporated urea at various depths-

Rochette et al., 2014, J. Env. Q.

Period-hours	Surface (% loss)	1 inch (% loss)	2 inch (% loss)	3 inch (% loss)
0-1 week	2.2	18.4	2.6	0.0
1-2 weeks	29.5	15.2	3.2	0.1
2-3 weeks	15.2	3.8	1.8	0.5
3-4 weeks	3.4	1.0	1.0	0.0
Total	50.3	38.4	8.6	0.4

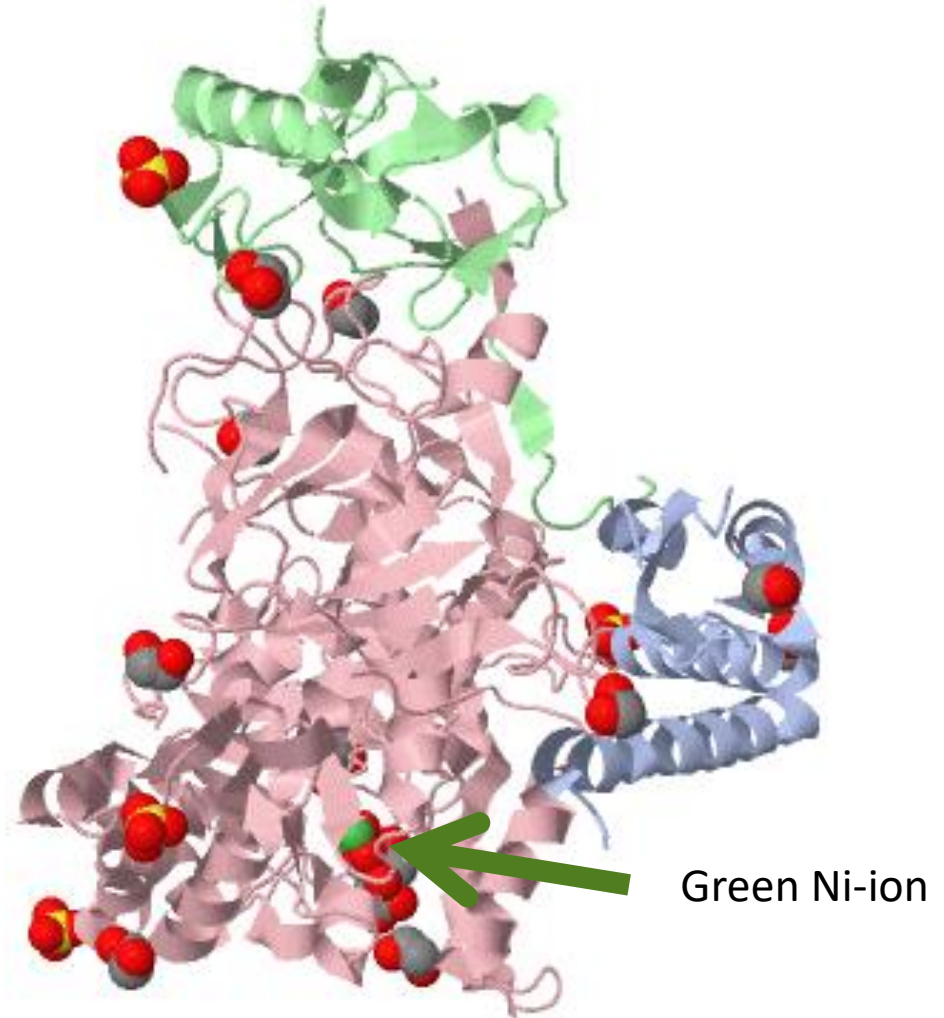
Slightly acid silt loam soil

Urease enzyme

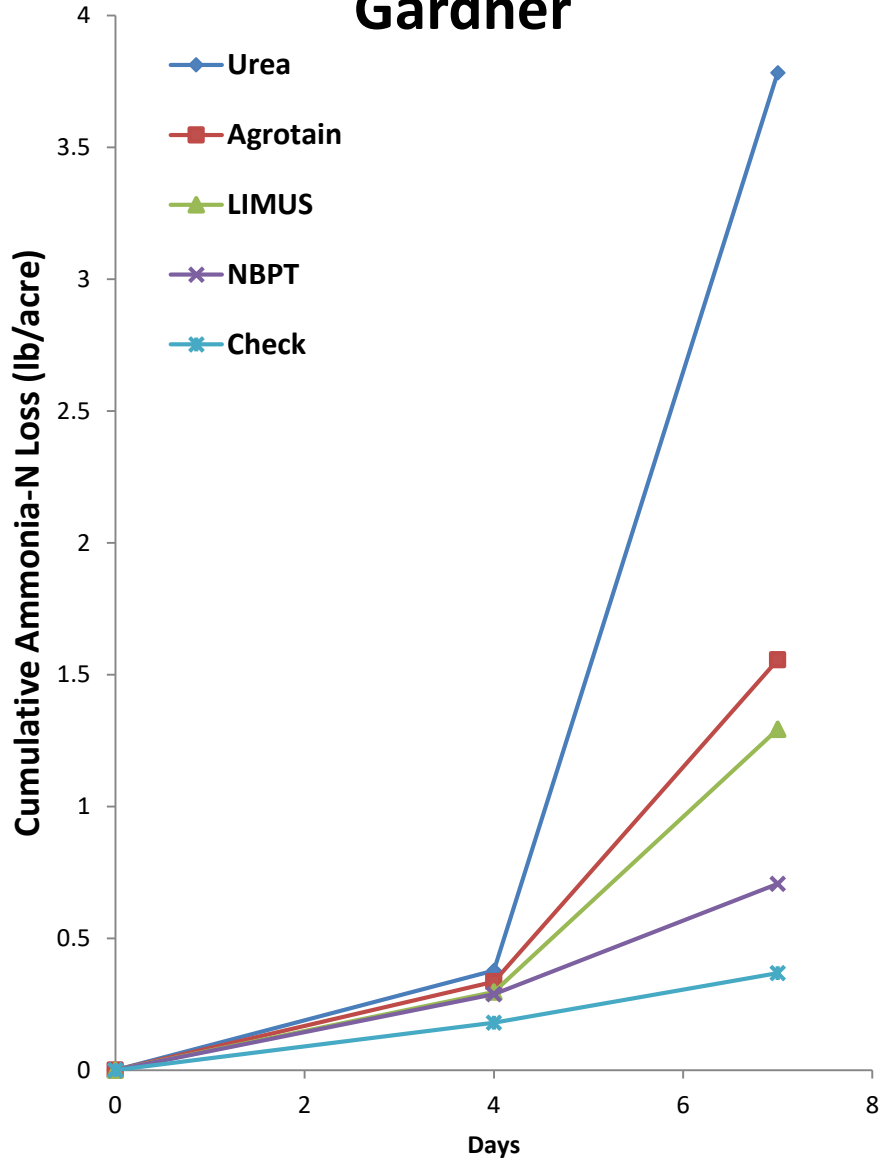
<http://www.proteopedia.org/wiki/index.php/Urease>

Urease is produced by plants, bacteria, fungi, invertebrates and is one of the last compounds to degrade after the organism dies.

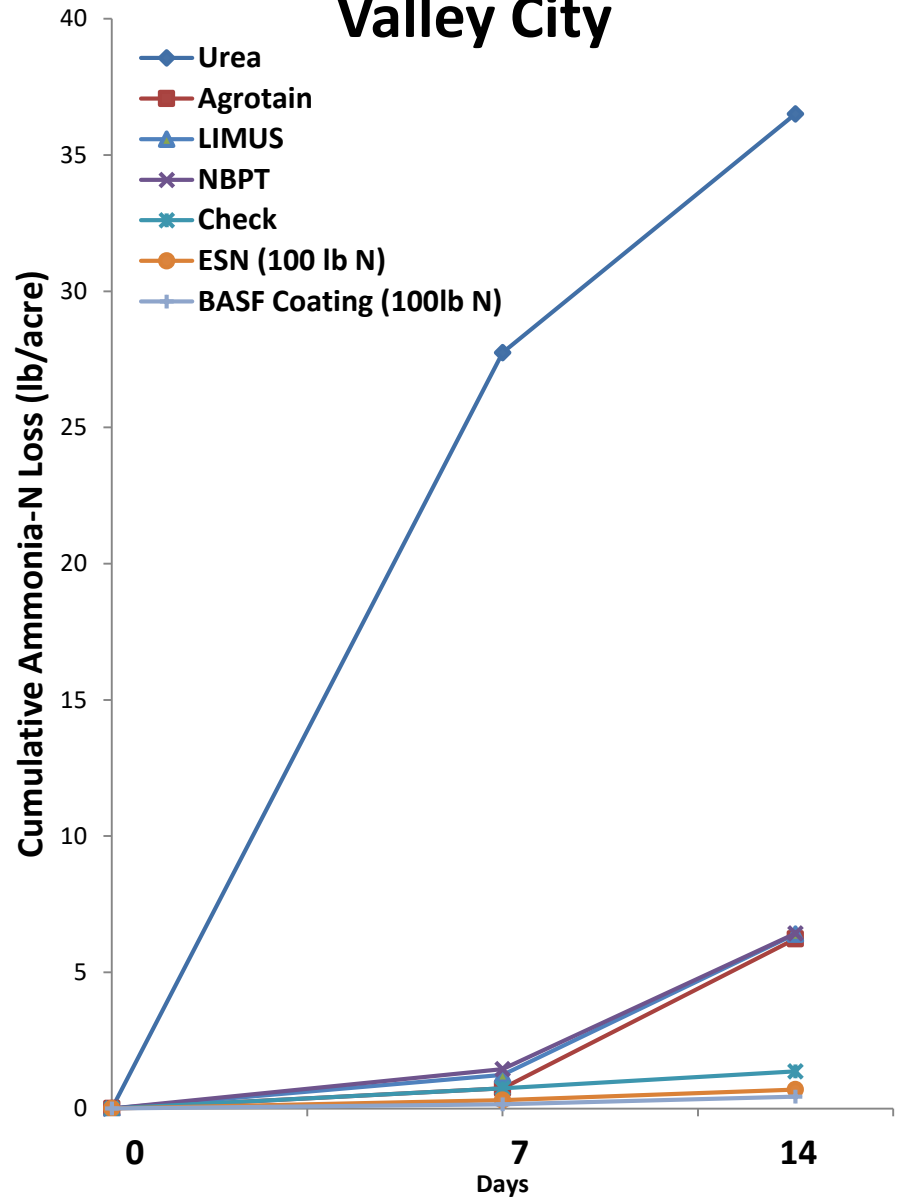
‘The Zombie Enzyme’



Gardner



Valley City

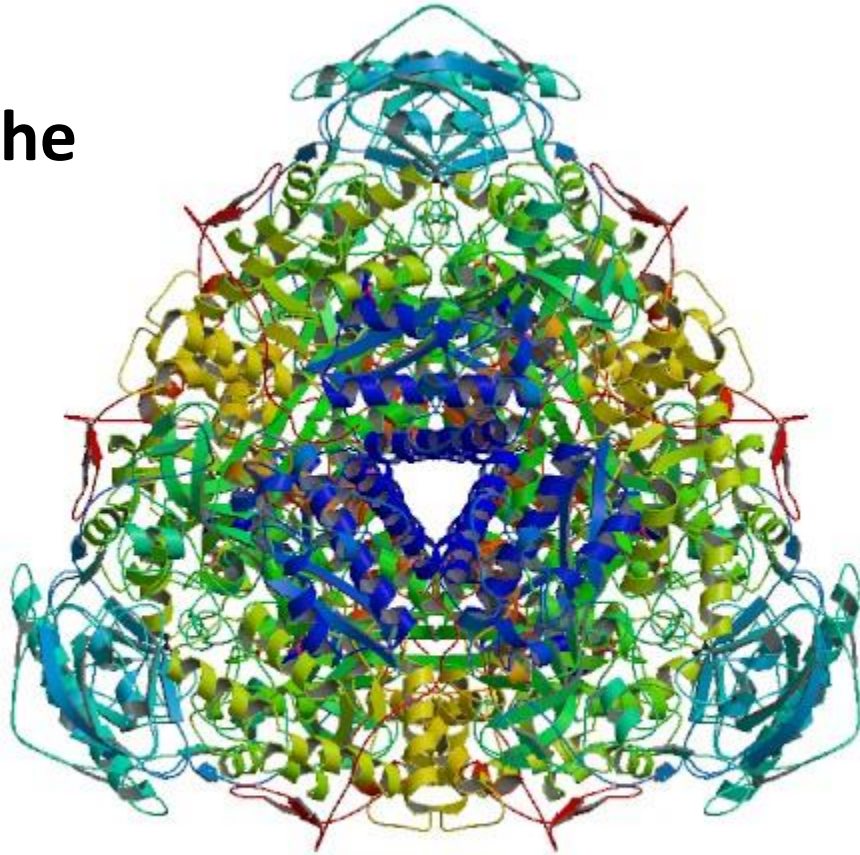
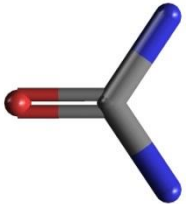


Ammonia volatility from surface/near surface application increases with

Residue

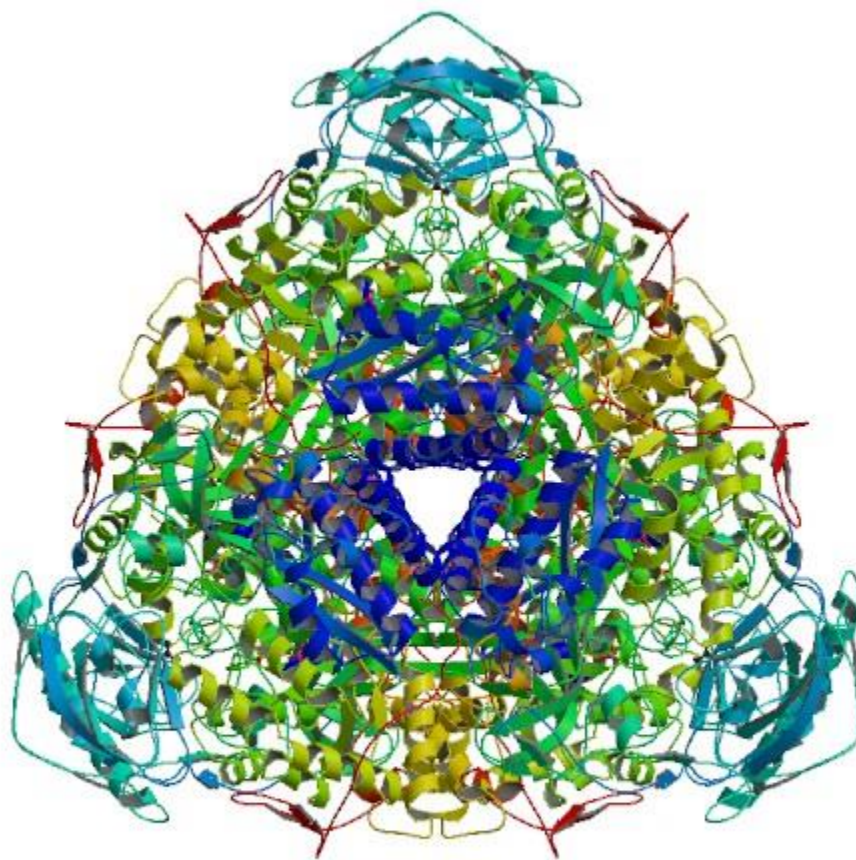
Soil pH

**Urea is acted on in the
'keyhole' structure of the
urease enzyme**



N-(N-Butyl)thiophosphoric triamide

Has same tri-atom configuration as urea



NPPT has same tri-atom structure, but tail has an additional C group.

**NBPT (Agrotain and siblings)
and
NPPT (Limus)**

**are the only chemistries known to inhibit
urease activity for days (usually about 10)**

**Ammonium thiosulfate has measureable
short-term activity, but NBPT is much better.**

**26.9% NBPT, 3 qt/ton (Agrotain)
use equivalent a.i. NBPT/ton**

Don't forget starter P for wheat

Chloride not important for wheat as it is for malting barley

especially if soil test is low (<10 lb/a).

Increases plump and helps to reduce effect of lower barley yield due to reduced kernel size.

Summary-

- Use of the N calculator for wheat for most profitable N rates. Use common sense to determine the rate best suited to your farm and variety.**
- Yield goal is not a factor in N rate**
- Band apply P**

SOIL FERTILITY OF SOYBEAN - RECENT ND RECOMMENDATION CHANGES



- **Iron chlorosis - yellowing between veins of youngest leaves.**
- **Chlorosis not seen until the 1st tri-foliolate.**
- **Iron is mobile in the plant through the mono-foliolate stage.**



The main form of iron (Fe) in soil is oxidized iron (Fe^{+3}).

Fe^{+3} is a trillion times less soluble than Fe^{+2}

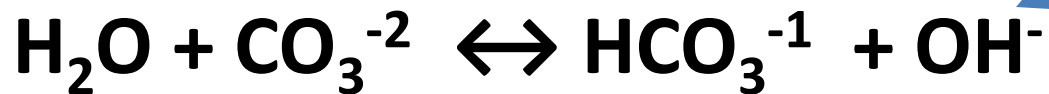
Soybean roots secrete organic acids and H^{+}

They also secrete a protein (enzyme) that reduces Fe^{+3} to Fe^{+2} , increasing its availability to the soybean by a factor of 1,000,000,000.

But the protein is only effective if the pH is acid around the root!

If the soil pH is > 7, that means that the soil is dominated by carbonates.

(If soil pH > 7, carbonates are present)

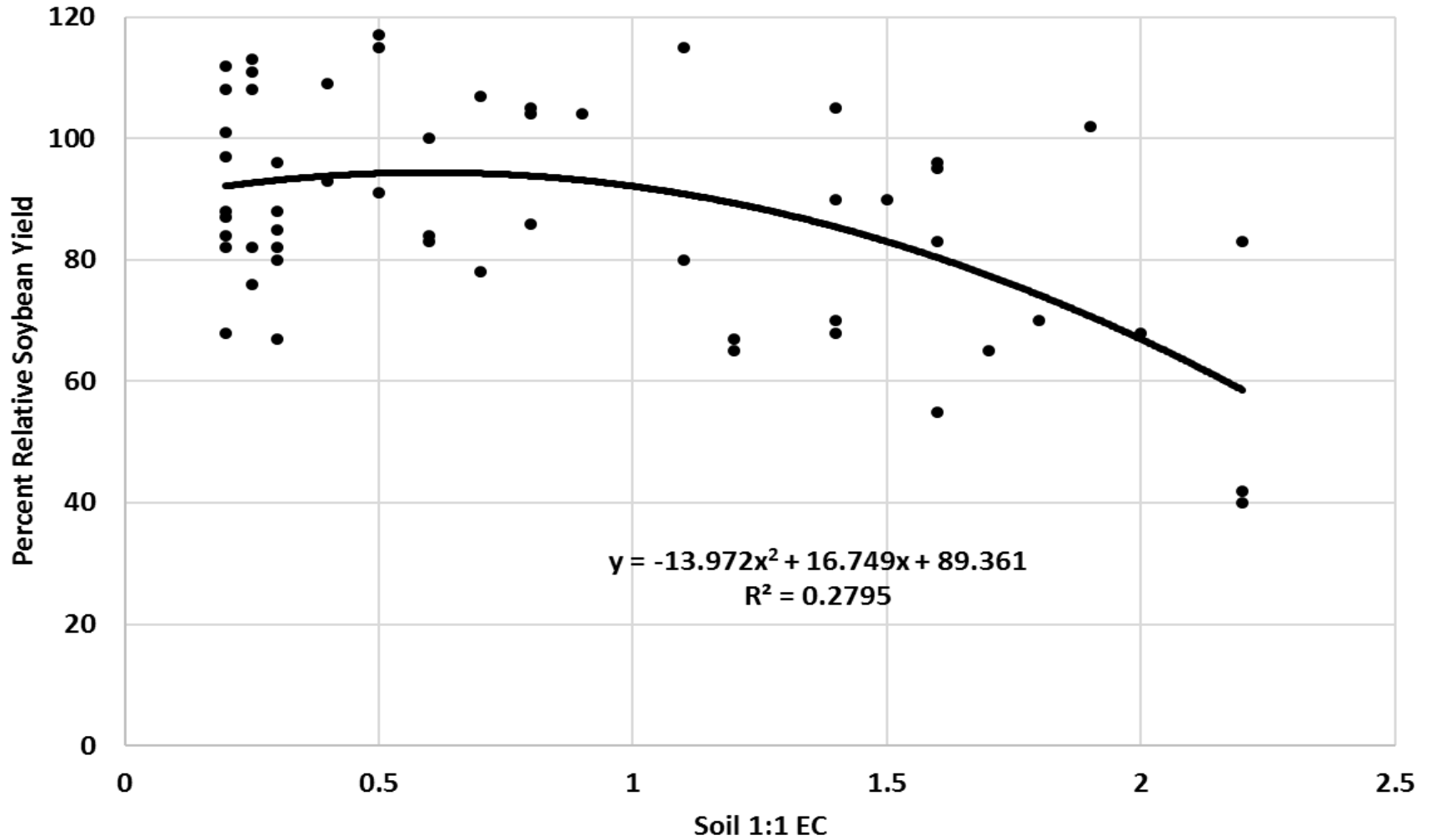


(water plus carbonate goes to bicarbonate and hydroxyl ions)

Additional stress causes increased IDC if carbonates are present and environment supports IDC development

(Wet soils, cooler soil temps, herbicide stress).

Soybean yield is reduced to about 85% even without IDC at EC 1.5



Field selection-

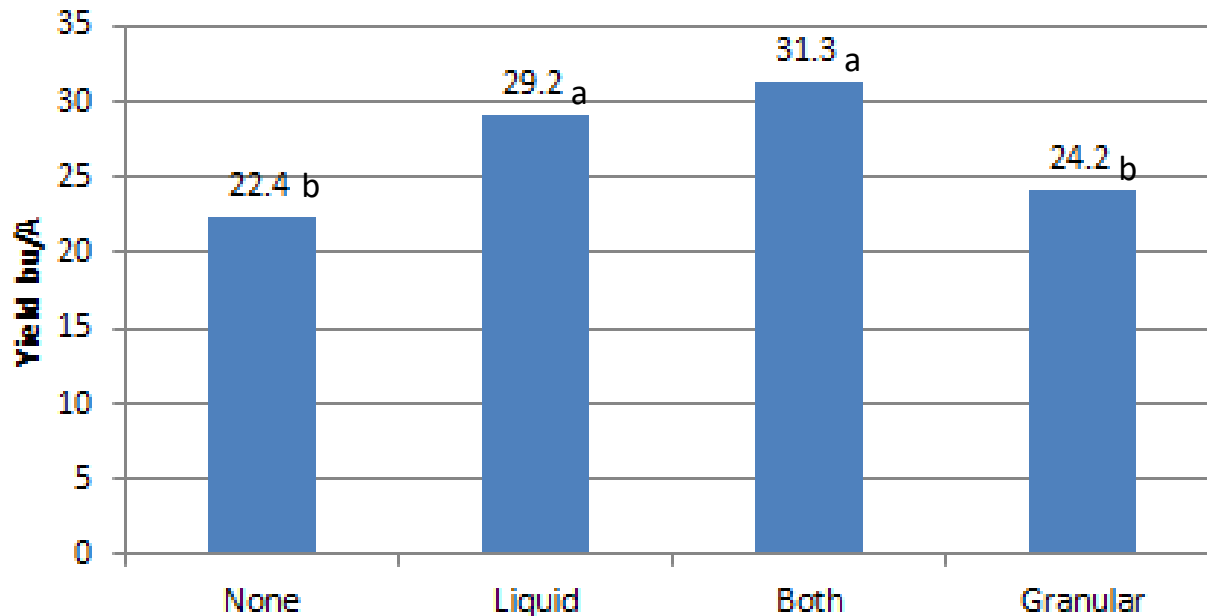
Select fields with EC no higher than 1.5

**New Soybean Fertility Circular 2019
available on-line**

Search for <soybean fertility NDSU Extension>

Inoculating virgin soybean ground

Yield of Soybean Grown Using Different Inoculant-2014 Minot, ND



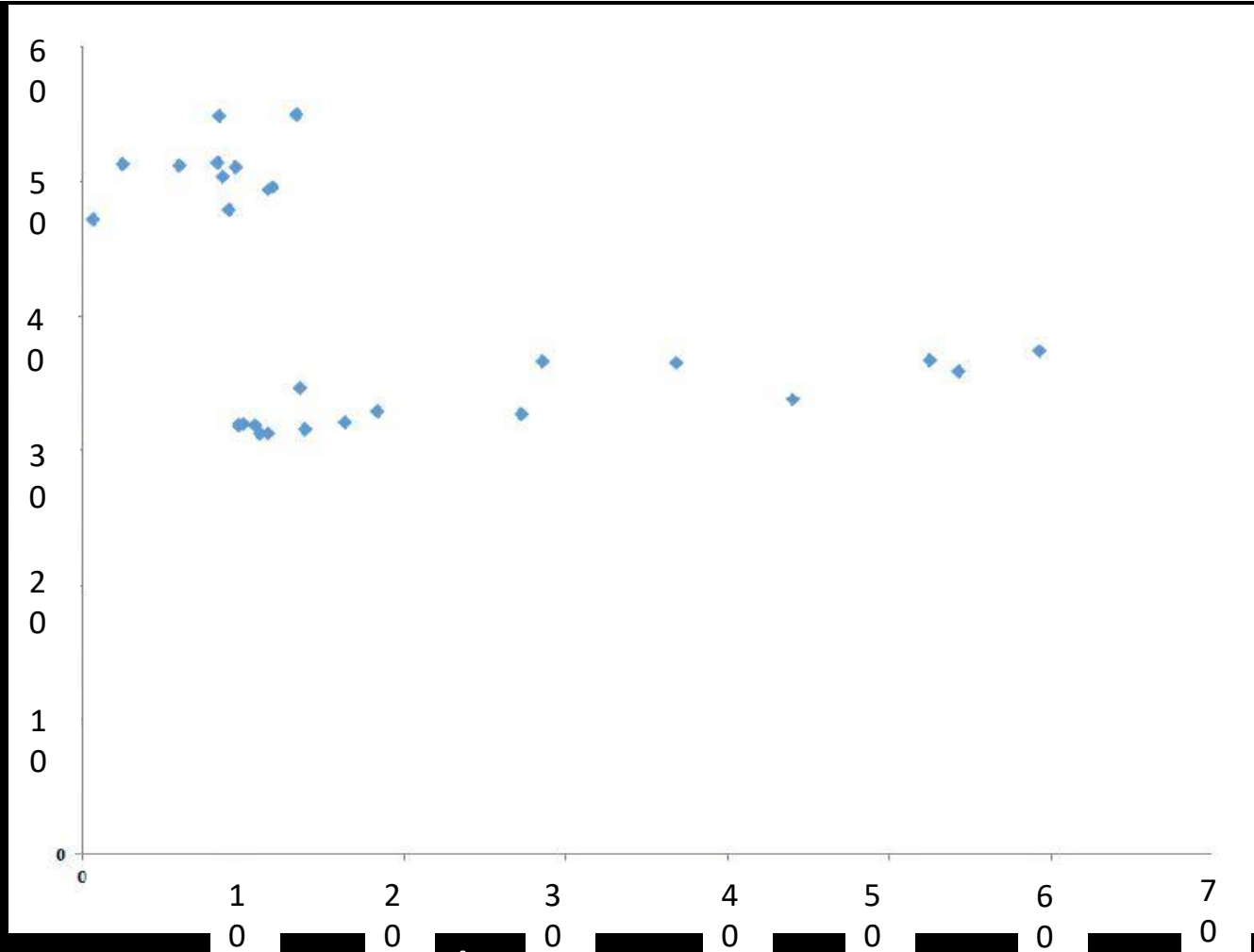
Forster, 2015

If soybean had good nodulation, you'll likely not see a response from inoculation

Time since last soybean crop	Bradyrhizobium cells per gram of soil
1 year	19,534
2 years	3,718
3 years	2,464
4 years	2,234

Soybean Soil Fertility, Franzen et al., 2019

Yield (bu/ac)



Inoculation is not necessary or helpful if the field has been in a successfully nodulated soybean field within the past 4 years.

Supplemental N is not helpful unless the nodulation is a total disaster and the leaf tissue indicates N deficiency.

Rescue N application only profitable on virgin ground or no nodulation. R3 N application

Treatment	Yield (bu/ac)
100 lbs N/ac as urea	34.5a
100 lbs N/ac as UAN	32.9a
50 lbs N/ac as UAN	29.0ab
50 lbs N/ac as urea	25.9bc
Untreated	21.9c
LSD 5%	6.2

Endres, Aberle, and Henson, 2002

P is only needed for yield increase when soil test is 7ppm or less.

**Broadcast or band-seed separated
P is best.**

Seed-placed P does not increase yield in most trials and can decrease yield especially if the soil becomes dry after seeding.

Phosphorus rates

Olsen P test, ppm				
Very Low	Low	Medium	High	Very High
0-3	4-7	8-11	12-15	16+
-----lbs P ₂ O ₅ /ac-----				
52	26	0	0	0

Soybean Soil Fertility, Franzen et al., 2019

Kalra and Soper, 1968

Bardella, 2016

Soybean prefers broadcast P

P ₂ O ₅ /ac	Placement Method	
	Broadcast	2x2in Band
	---Yield (bu/ac)---	
0	35.5	34.3
20	39.6	35.3
40	41.1	36.2
60	44.0	39.1
80	42.4	37.1

Soybean Soil Fertility, Franzen, 2013, NDSU Extension

CREC In Furrow

Application Method	Stand 1,000 plants/ac	Yield bu/ac
Check	187.5a	32.8a
2x2 4gal/ac	188.6a	33.5a
In furrow 4 gal/ac	133.2b	24.5b
In Furrow 8 gal/ac	120.6b	18.9c
LSD 5%	16.5	4.3

Endres and Hendrickson, 2008

**There is no safety advantage of
'low-salt' starters compared to 10-34-0
based starters.**

**'Low-salt' starters contain urea or UAN,
which is at least as harmful to the seed
as salt.**

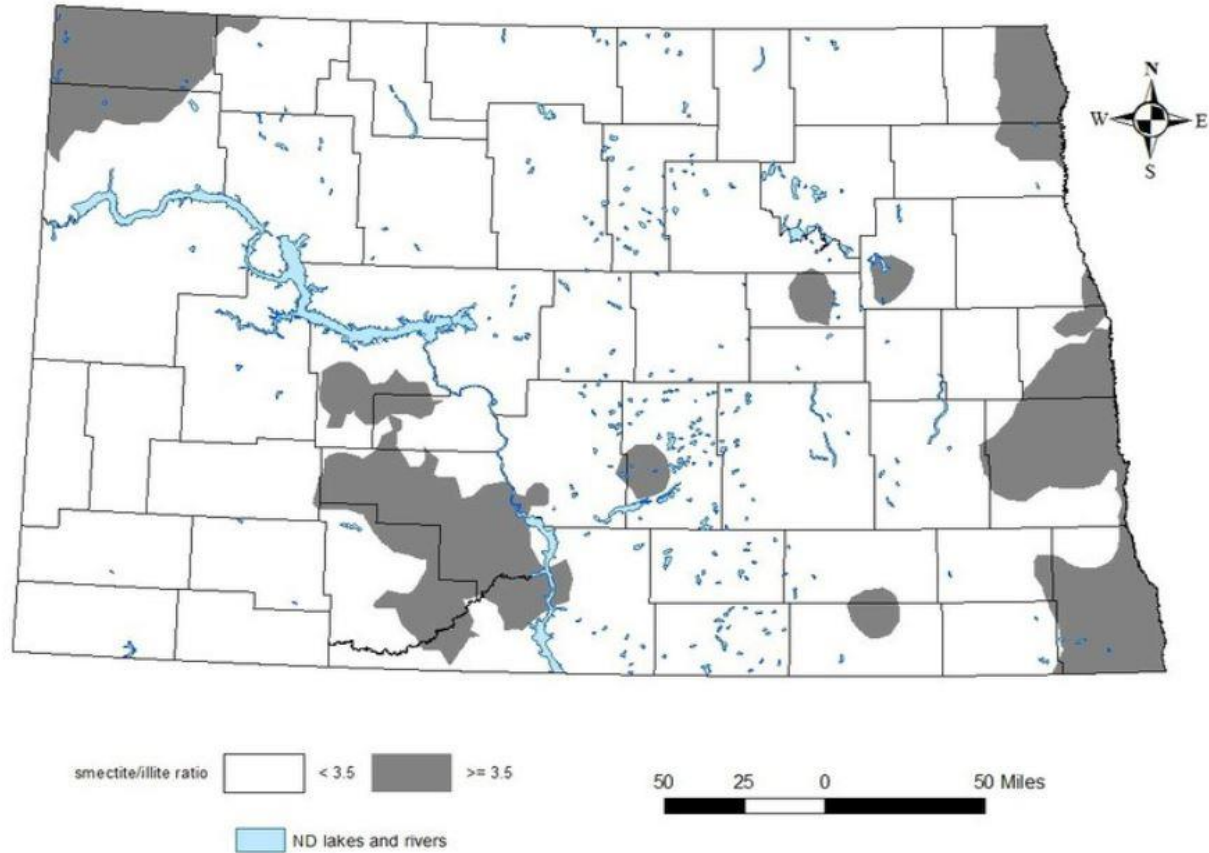
Potassium rates

Ammonium acetate K test, ppm

VL/VL	L/L	M/M	H/M	VH-H	VH/VH
0-40	41-80	81-120	121-150	151-200	201+
-----lbs K ₂ O/ac-----					
90/90	60/90	60/60	30/60	0/60	0/0

Soybean Soil Fertility, Franzen et al., 2019

Smectite:Illite Potassium Thresholds



**In-season foliar sprays for N, P, K
are almost never effective at
\$ payback let alone profit.**

**2 treatments each site in NC and
NW ND, 6 site years- no effect on
yield at 2 different timings (2016-2019).**

Soybean is much more able to extract S from the soil compared to wheat or corn.

Soybean may respond after a year like 2019 and snow like so far in 2020 on SANDY, higher topography location soils.

Rescue of S deficient soybean is possible in-season (soybean is an August crop).

NDSU finds no need for micronutrient supplements in North Dakota.

Except Fe

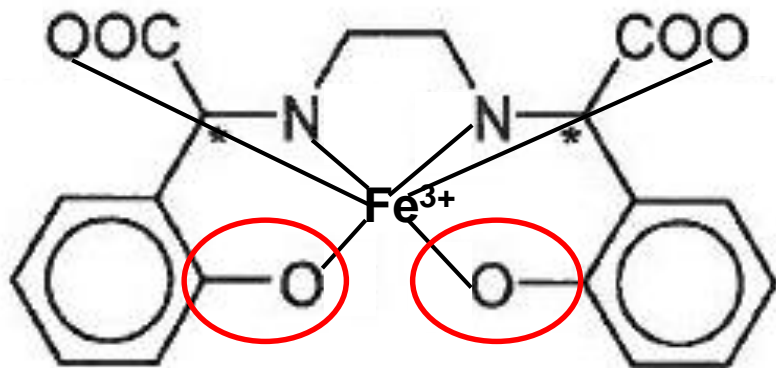
**Fe-o-o-EDDHA is the best so far
iron fertilizer for soybean-
in-furrow at seeding. Follow
label directions.**

**Try to use a product with the
highest ortho component.**

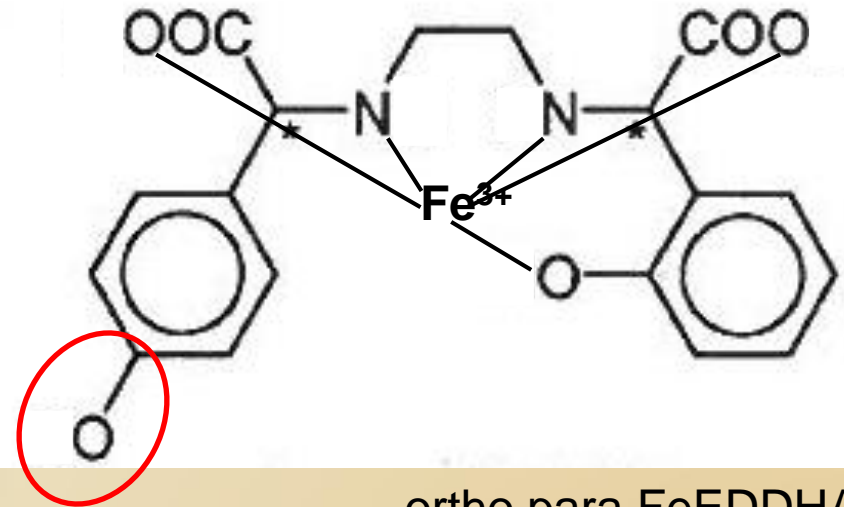
**Take care of field selection,
variety selection first before
using Fe fertilizer to overcome IDC**

FeEDDHA Fertilizer Quality

Due to differences in FeEDDHA isomer concentrations



ortho,ortho FeEDDHA



ortho,para FeEDDHA

A companion crop of oats/barley may serve to dry out the soil a little and take up some nitrate, reducing IDC.



Without oats



With oats

J. Lamb images, used with permission, U of MN