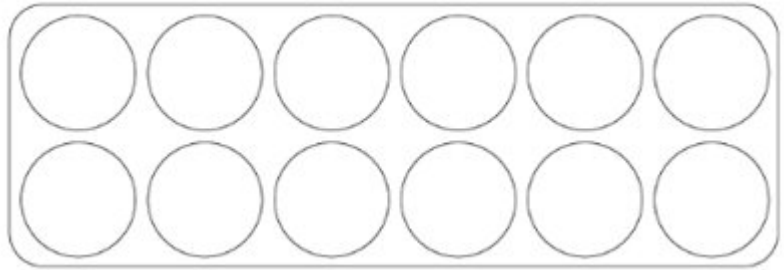
Bio-Gel

Chris Kniffen, Director of Research

Midwestern BioAg™

Bio-Gel®

- Carbohydrate based hydrogel
- Bio-Gel encapsulates and retains nutrients, carbon, biology, etc
- As a carbo-based hydrogel, the product retains water, simulates biology, and is biodegradable
- Active ingredient is a common carbon fraction found in root exudates



Initially offered as a dry granular, market demand for liquid concentrates led to development of stable liquid formulations

Bio-Gel® RootSurge®

- Formulated for liquid in-furrow applications
- Maximizes belowground biomass
- Ideal for alkaline water / solutions

Bio-Gel® NSurge™

- Formulated for side-dress applications with UAN
- Retention agent
- Ideal for neutral to mildly acidic solutions

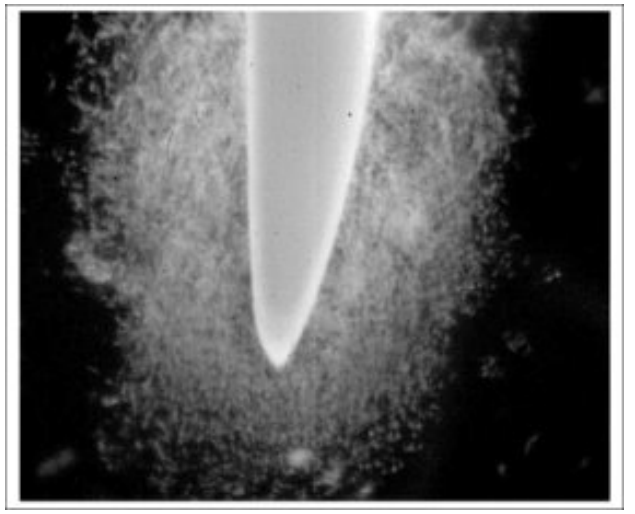
Bio-Gel®

Primary target for Bio-Gel development was a root exudate

Regenerative farming practices prioritize the value of root exudates for soil formation / stabilization

Developing innovations mimicking a root exudate transfers the value of the root exudate to companion products that can be managed by farmers / agronomists

We hypothesized that the expected outcomes of the innovation will benefit plant health, nutrient retention, and yield, along with the ecosystem services of regenerative farming



Border root cap mucilage of cotton

Aerial root mucilage of corn

Bio-Gel®

Bio-Gel Trial Experimental Site Locations

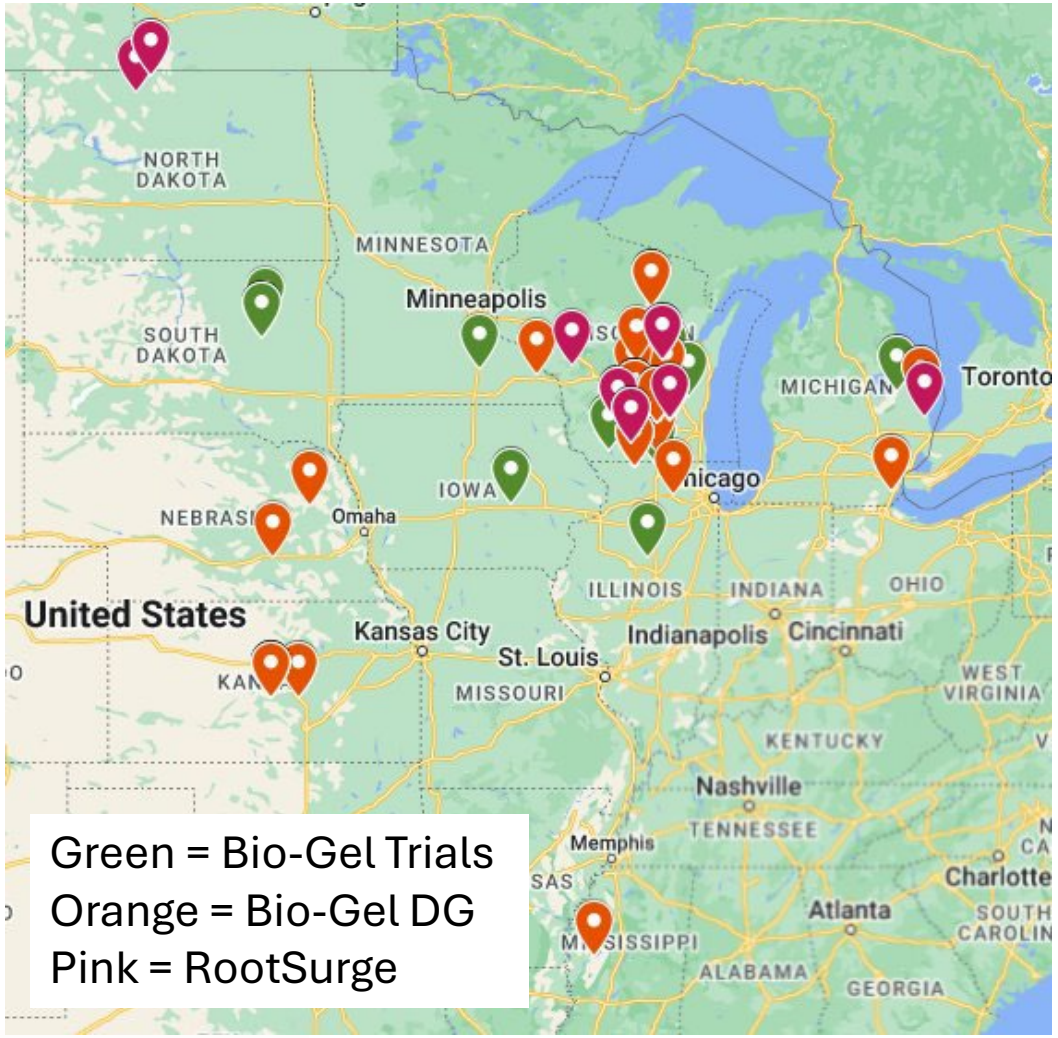
Corn

In-Furrow

- *West Central Wisconsin*
- *Southeast Wisconsin*
- *Eastern Wisconsin*
- *South Central South Dakota*
- *North Central North Dakota*

Side-Dress (Pivot, y-drop, 2X2)

- *West Central Wisconsin*
- *Central Iowa*
- *Northeastern Michigan*
- *South Central Minnesota*
- *Central Kansas*



27 soil types

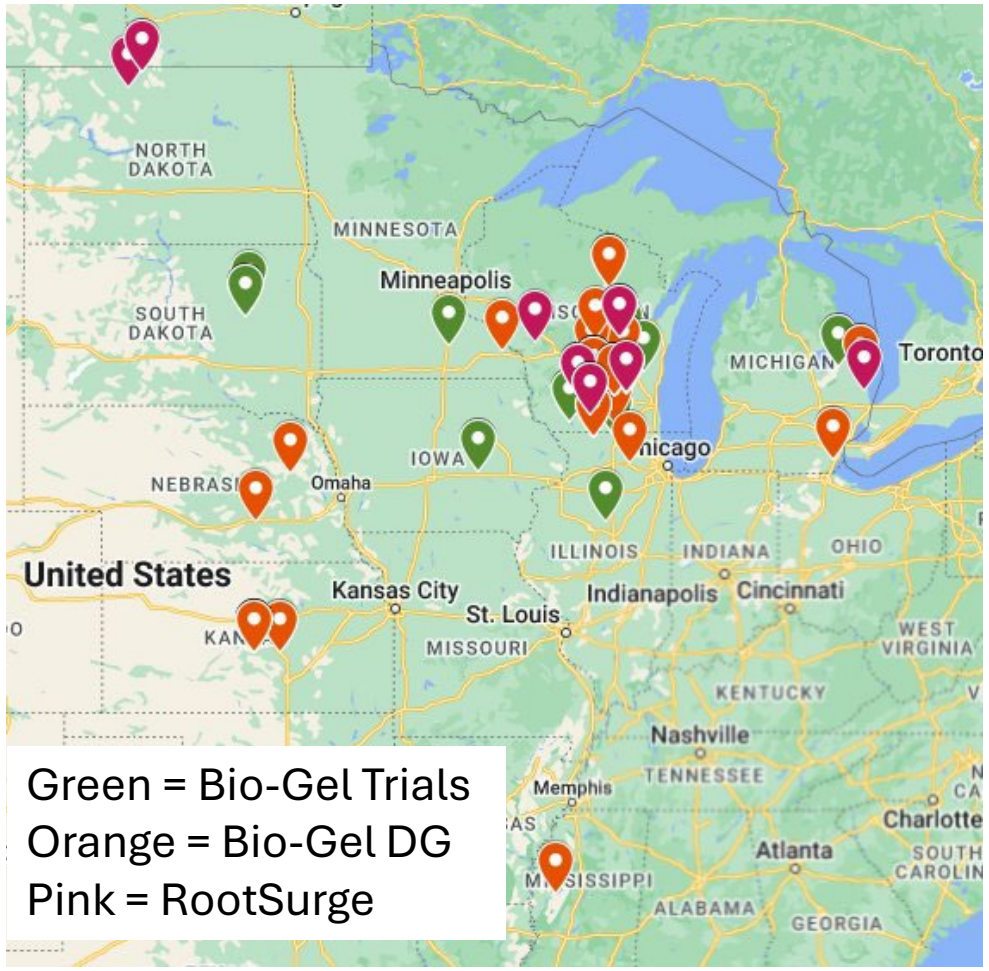
Bio-Gel®

Bio-Gel Trial Experimental Site Locations

In-Furrow

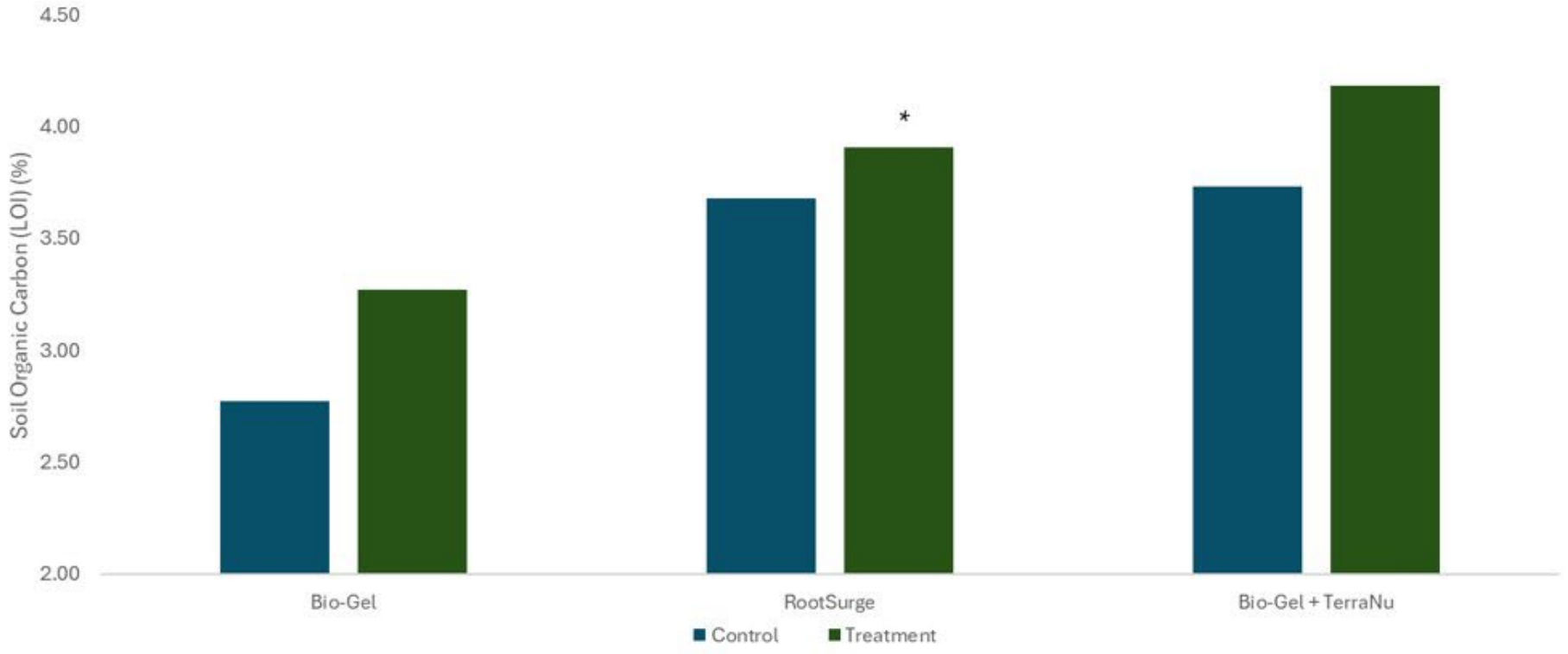
- *West Central Wisconsin*
- *Southeast Wisconsin*
- *Eastern Wisconsin*
- *North Central North Dakota*

7 soil types



Bio-Gel®

All Bio-Gel formulations increased Soil Organic Carbon in corn production systems when applied in-furrow

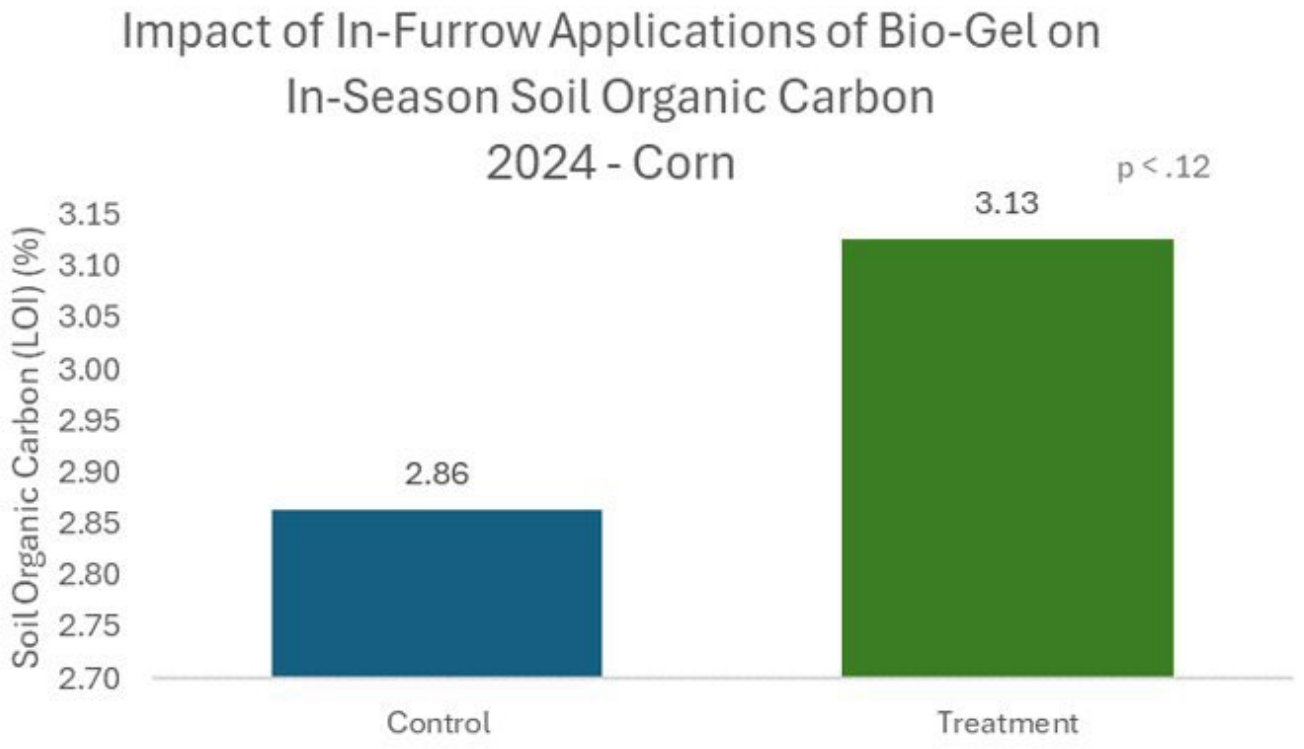


Bio-Gel®

Bio-Gel increased Soil Organic Carbon (SOC) 9% when applied as an in-furrow tank mix additive with the grower standard fertilizer program (GSP)

- 16 soil types sampled ranging from sandy loams to silt clay loams
  - 147 samples

- Despite a narrow variance (.26%), a reported increase in mean SOC was observed in 88% of the samples collected.



Bio-Gel®

Bio-Gel Dry Granular in Eastern Wisconsin

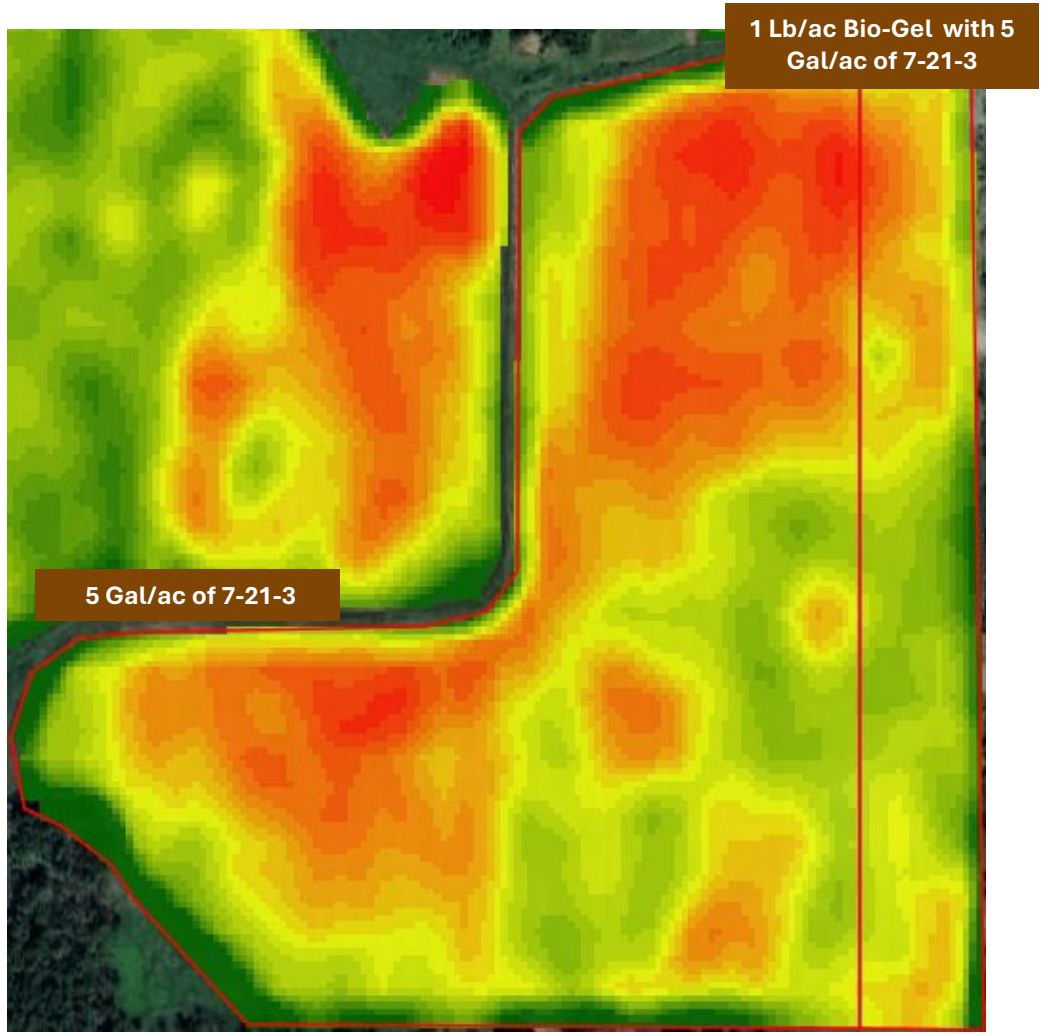
Treatment zone included headlands / turn rows

- 1 pound / acre Bio-Gel
- 5 gallons / acre 7-21-3

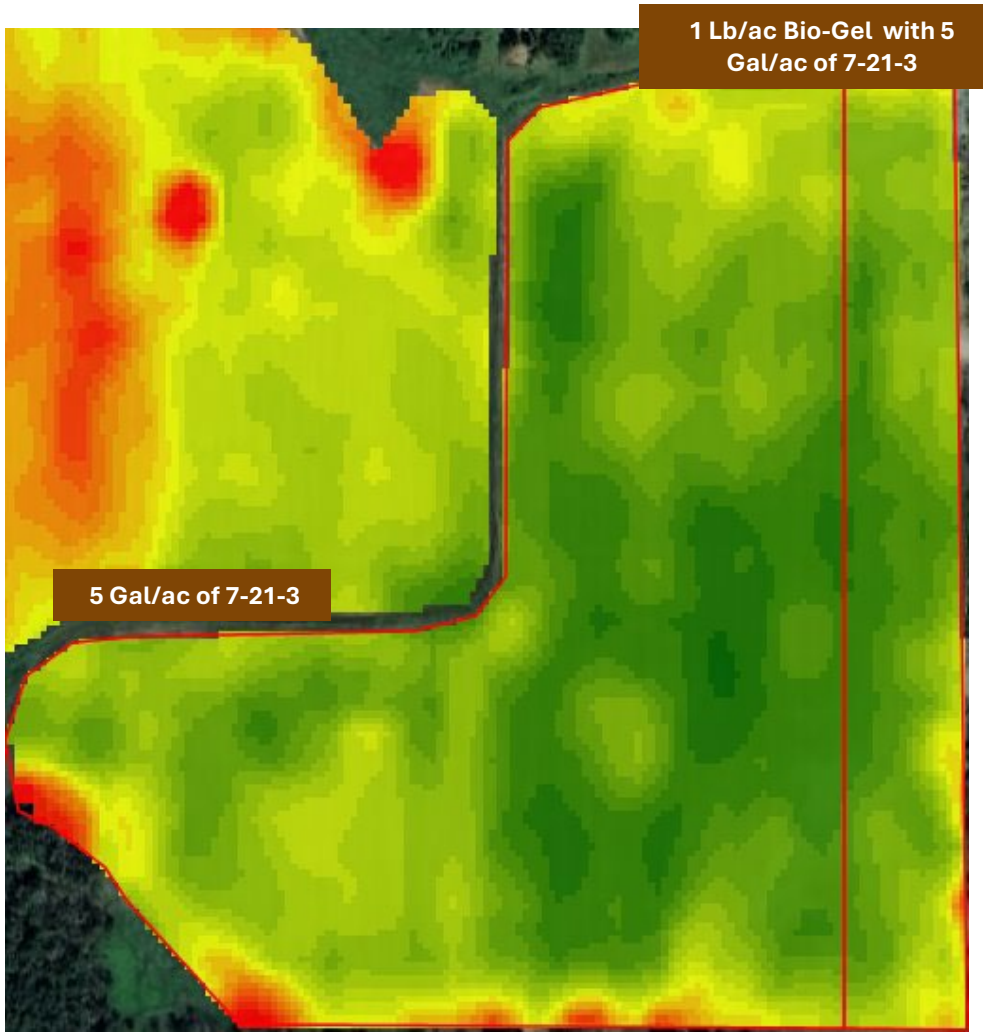
Grower Standard In-furrow program

- 5 gallons / acre 7-21-3

Bio-Gel®



NDVI imagery from June 26th, 2024.



NDVI imagery from September 4th, 2024.

Bio-Gel®

"We did 2 field lengths of each variable and found an average of 7 bu/ac advantage with Bio-Gel vs no Bio-Gel using the weigh wagon"

- Karl Harpstead, CCA

- **6.8 bu/ac uplift** in treatment area
- Soil organic carbon **increased 18%**
- Plant tissue nitrogen **increased 5%**
- Grower had previously not used a dry fertilizer program in 8 years

Bio-Gel®

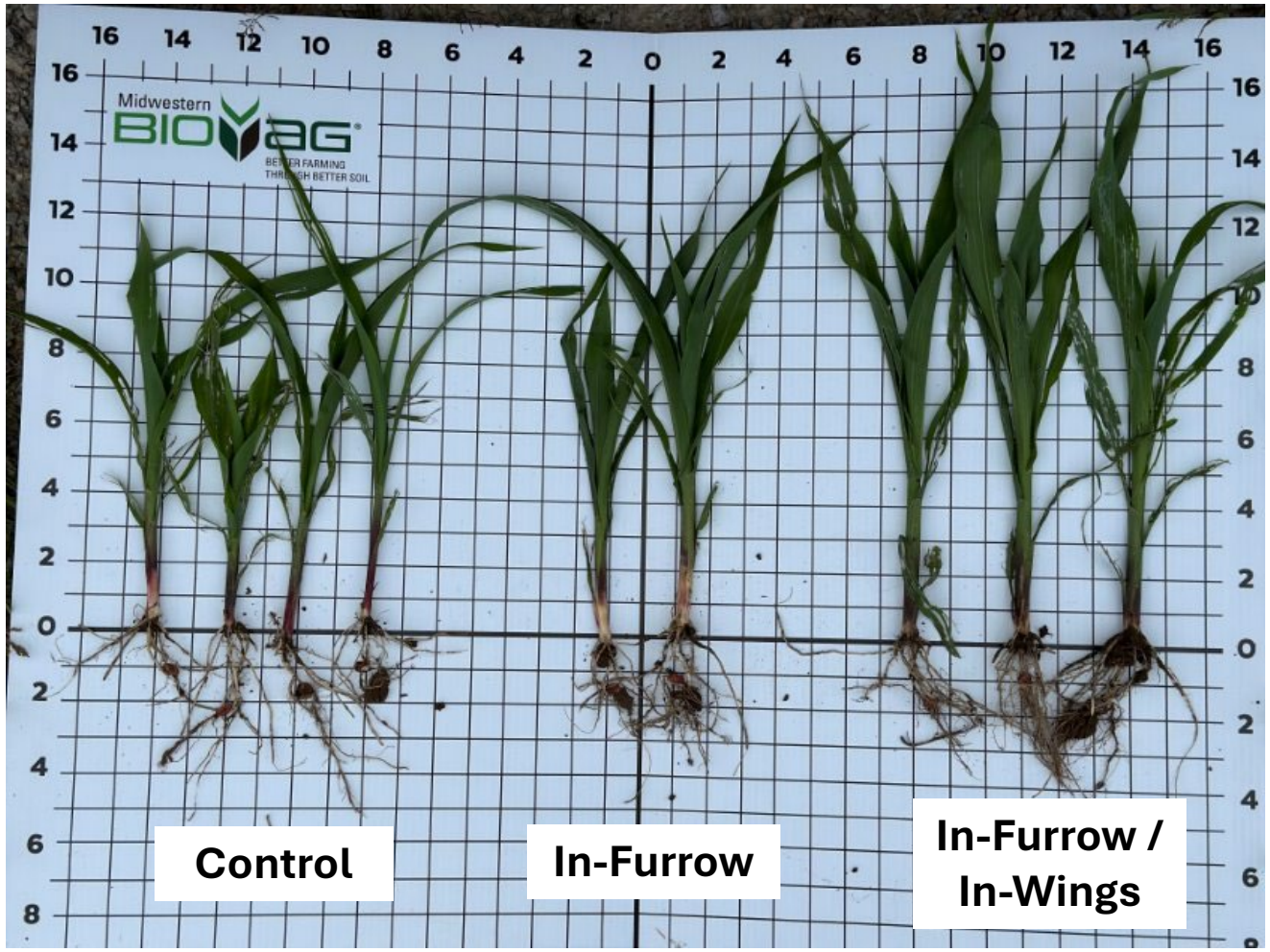
Bio-Gel in-furrow corn trials in north central Wisconsin reported improvements in early season vigor and standability

IN FURROW

- 1 Lb/A BIO-GEL
- 6 Gal/A 7-21-3 1 Qt/A Corn Spike
- 1/2 Gal/A Liqui-Life+
- 1 Pt/A Kelpak

IN WINGS (side dress @ planting)

- 9 Gal/A 20-0-0-8
- 3 Gal/A 0-0-25-19
- 1 Gal/A Boost
- 1 Pt/A 10% Boron
- 1 Qt/A Ignyte (biological)



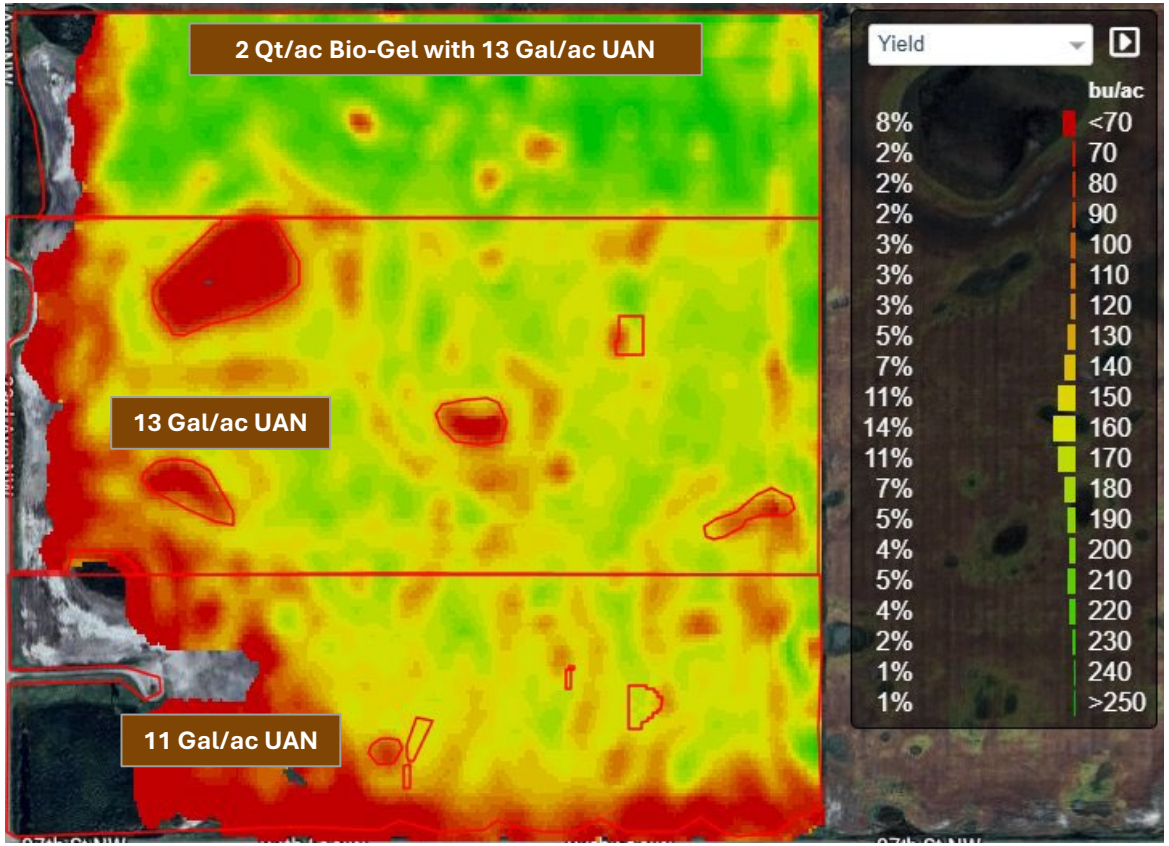
Bio-Gel®

Bio-Gel LC in-furrow on corn increased yields ~30% in NW North Dakota 2024 trial

- Bio-Gel LC applied at 2 qts per acre was tank mixed with 3.5 gallons per acre 7-25-3 and 13 gallons UAN

- **Corn yields increased 26%,** an uplift of 41 bushels per acre, compared to the grower standard practice of 13 gallons UAN per acre

- **Corn yields increased 35%,** an uplift of 51 bushels per acre, compared to the lower UAN rate grower standard program of 11 gallons UAN per acre



Trial site in Northwest North Dakota Yield Map

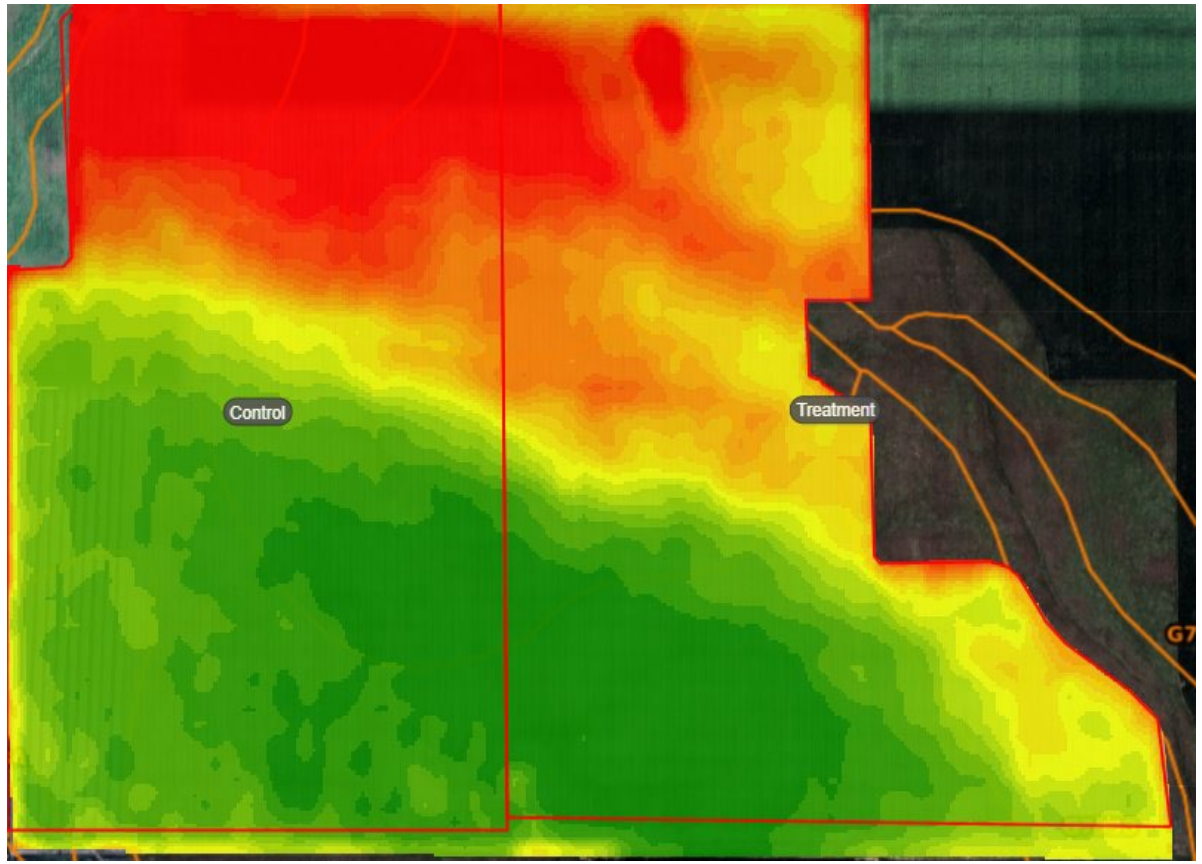
Bio-Gel®

Bio-Gel®

Bio-Gel trials in central South Dakota reported improved plant health and vigor

Bio-Gel LC "RootSurge" was applied in-furrow along with grower standard practice

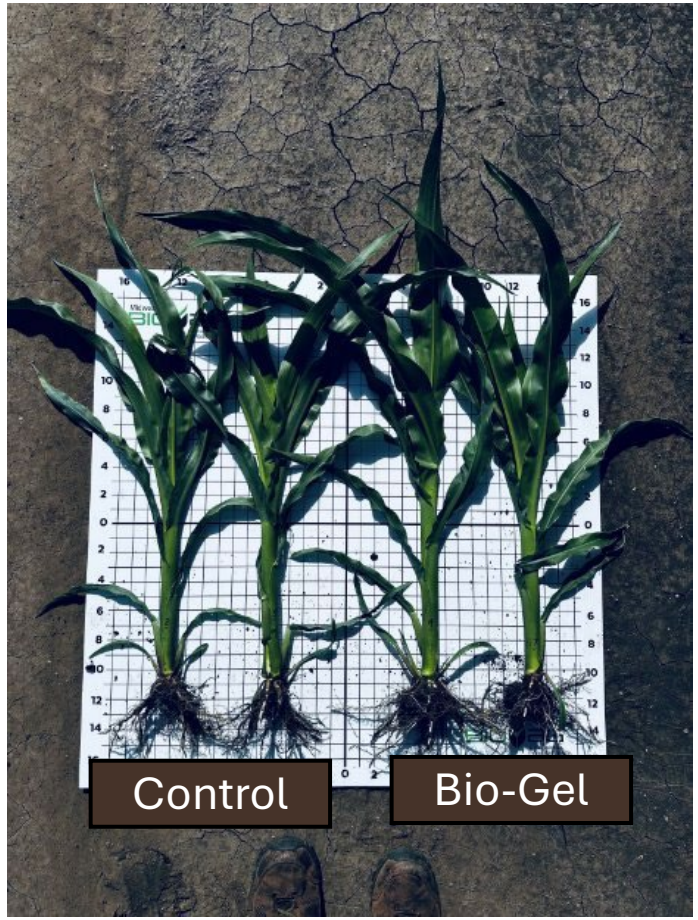
Midseason hail event limited yield results, however, still reporting notable improvements in plant health imagery despite hail event

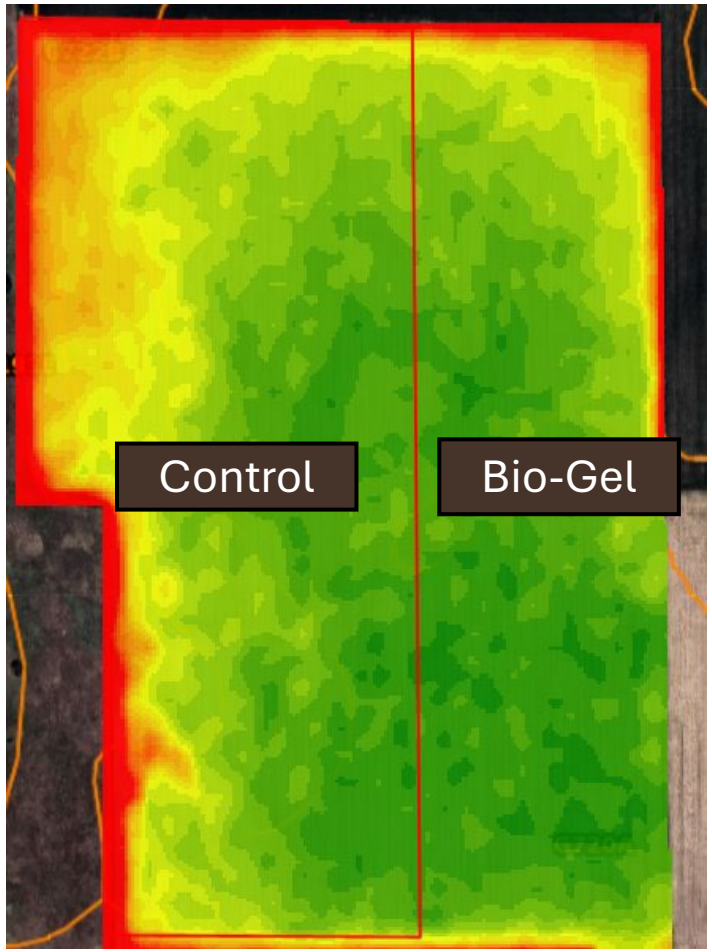


NDVI imagery from July 25th, 2024

Bio-Gel®

Along with plant health, mid-season sampling reported increased below ground biomass in treatments

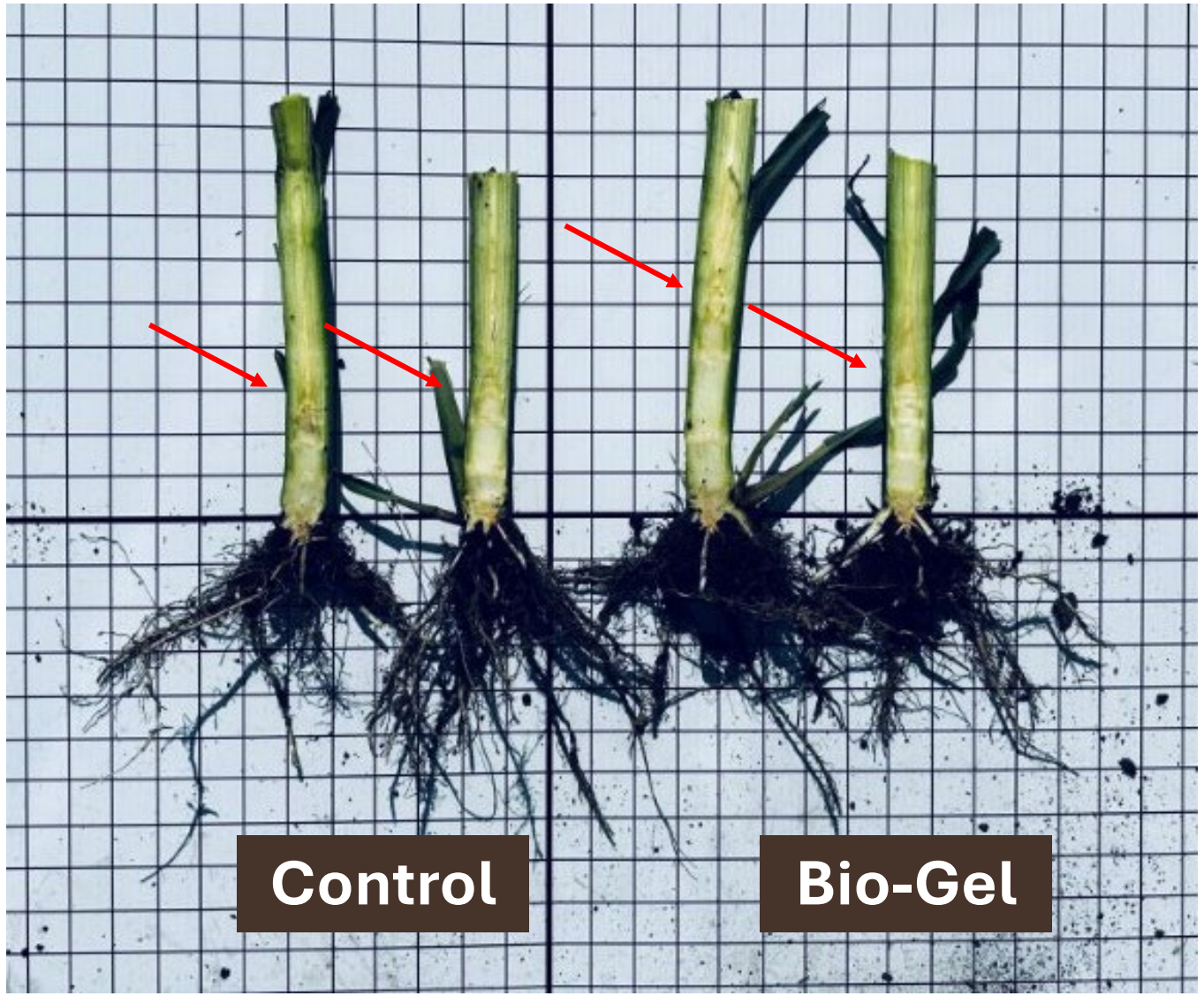




NDVI imagery from July 25th, 2024.

Bio-Gel®

Location of apical growing point in Bio-Gel treatment notably further developed vs. control



Bio-Gel®

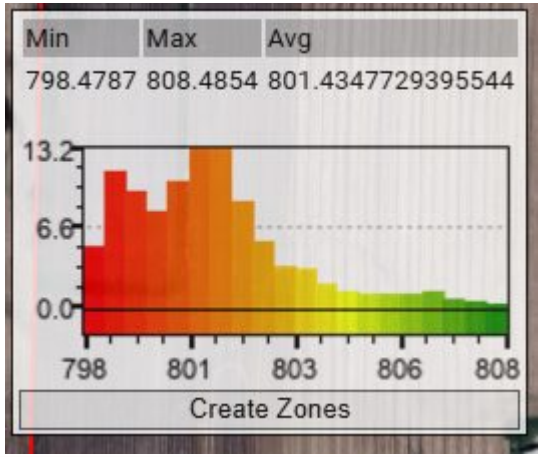
In-furrow Bio-Gel trial in central Wisconsin reported increased soil moisture and uplifts in yields

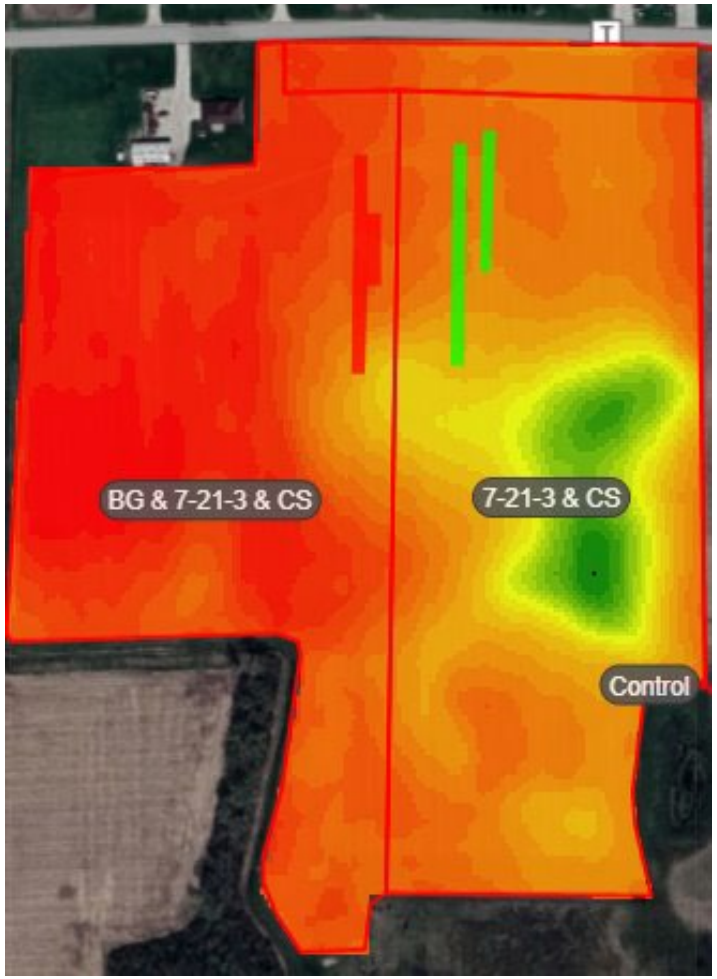
Treatment

- 2 qt/a Bio-Gel LC "RootSurge"
- 4.5 gal/a 7-21-3
- 1 qt/a corn spike

Control

- 5 gal/a 7-21-3
- 1 qt/a corn spike



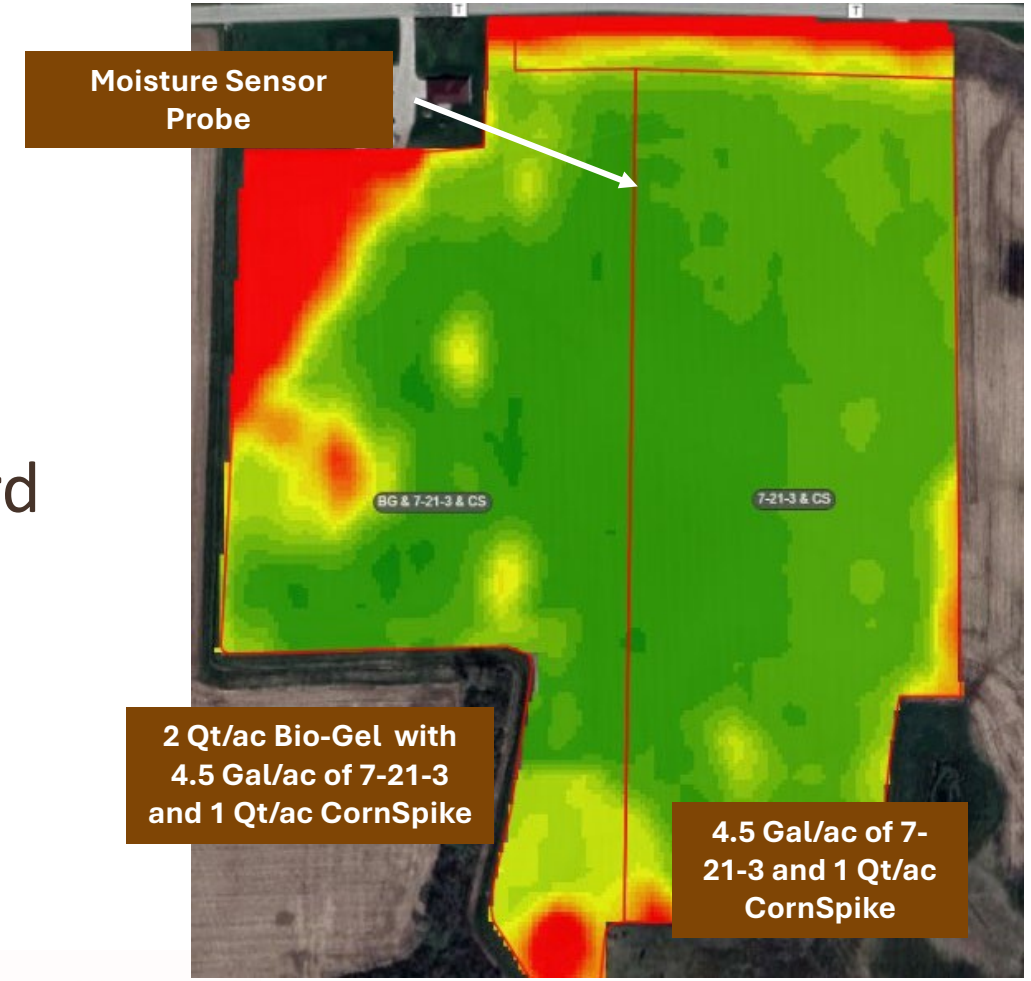


Elevation Map Experimental Site

Bio-Gel®

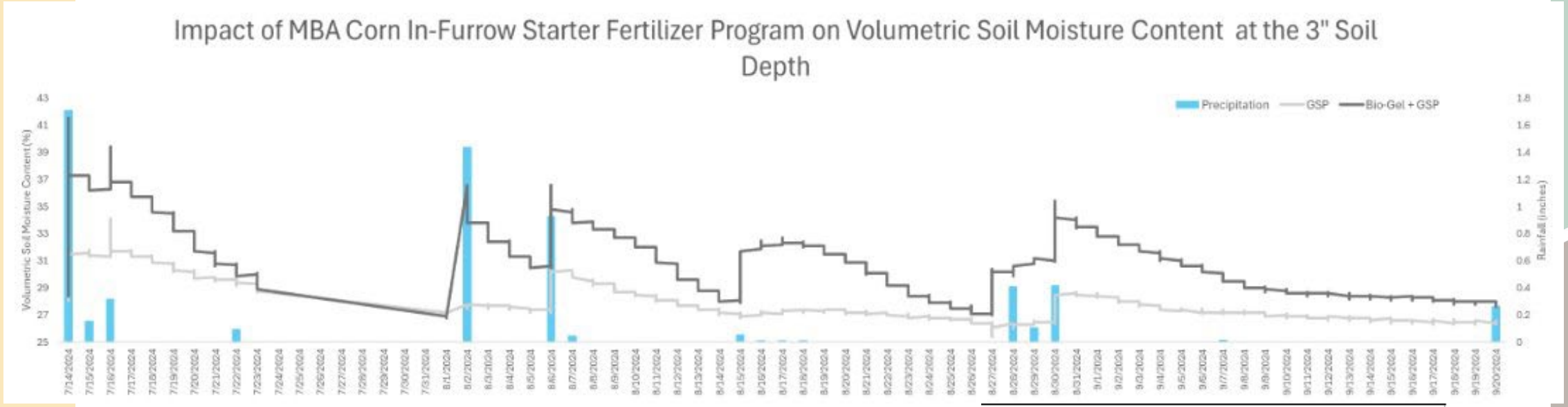
Along with water retention, late season NDVI observations suggest plant health and yield with Bio-Gel

***+ 2.53** bpa* yield increase with Bio-Gel as a tank mix partner with grower standard practice



Bio-Gel®

Bio-Gel increased soil moisture 10% at the Watertown, WI experimental site from July - September 2024.
The reported increase held .3216 inches more rain per acre than the GSP.



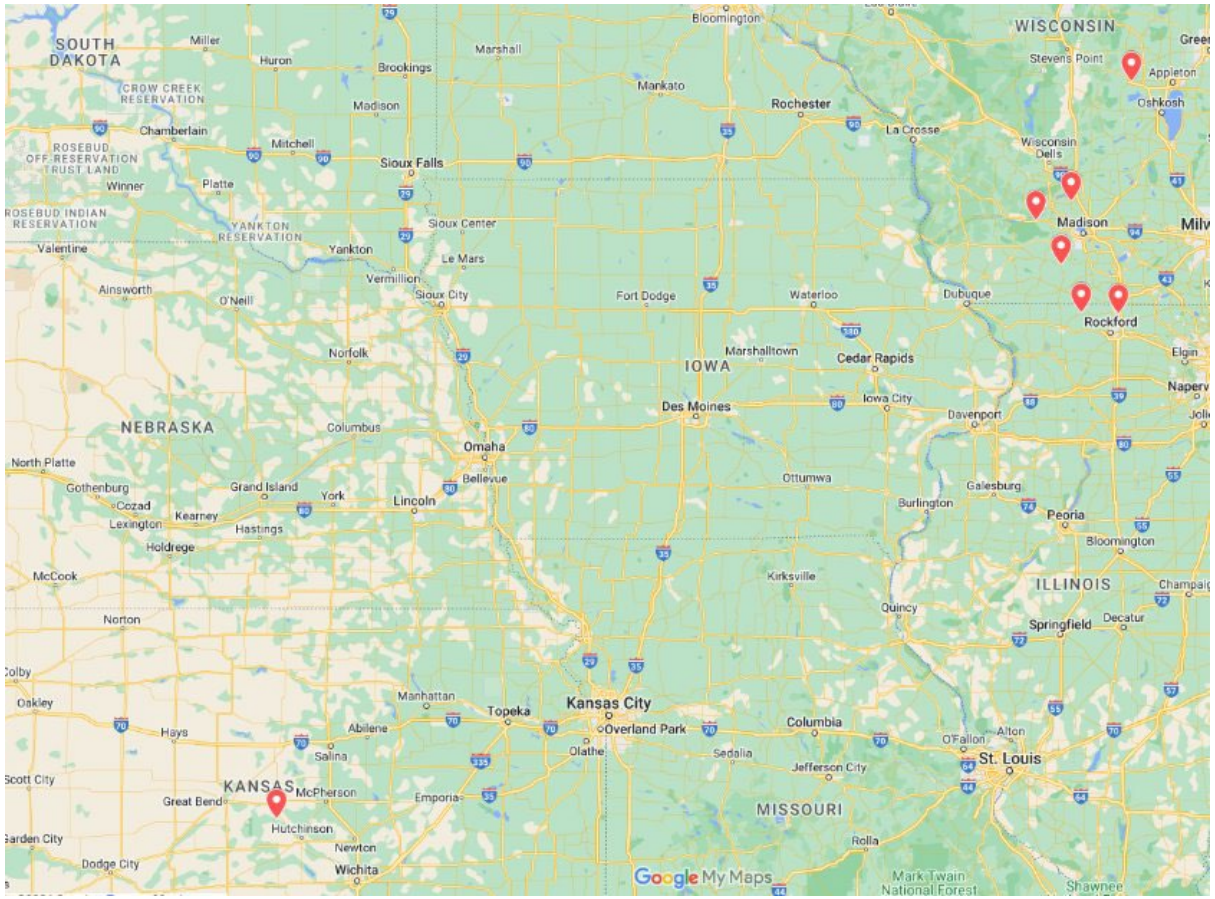
Post each rainfall event, Bio-Gel treatments retained and extended elevated soil moisture content 10 – 14 days over the control.

	Control	Bio-Gel
Mean	27.95	30.63
Variance		2.68
Percent Change		10%

Bio-Gel®

Site Descriptions for Bio-Gel Side Dress Applications

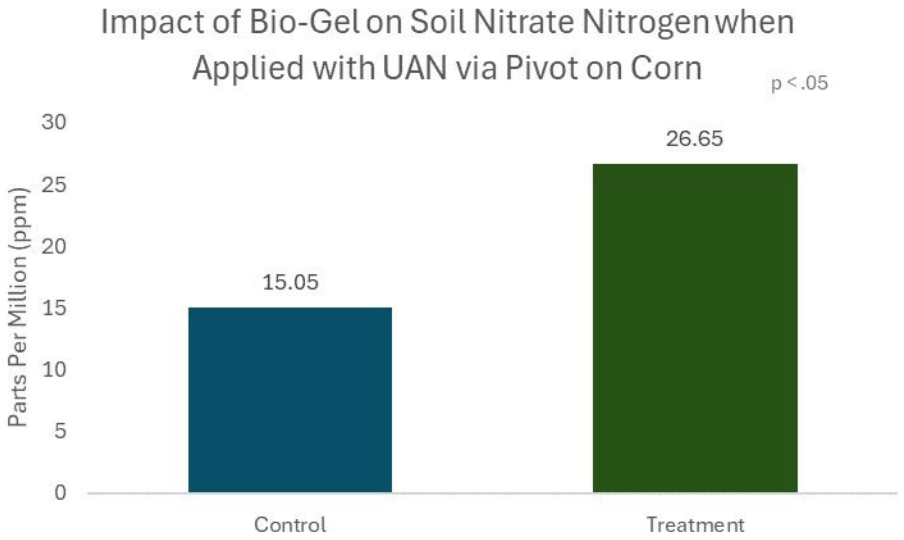
- Bio-Gel Side Dress was applied:
  - Central-Southern, Wisconsin
  - Southern, Kansas
  - Northern, Illinois
  - Northeast, Wisconsin
  - South-Central, Wisconsin
  - East-Central, Wisconsin
  - North-Central, Illinois
- Applications of Bio-Gel with UAN included y-drop, side-dress, and fertigation through overhead sprinkler pivot

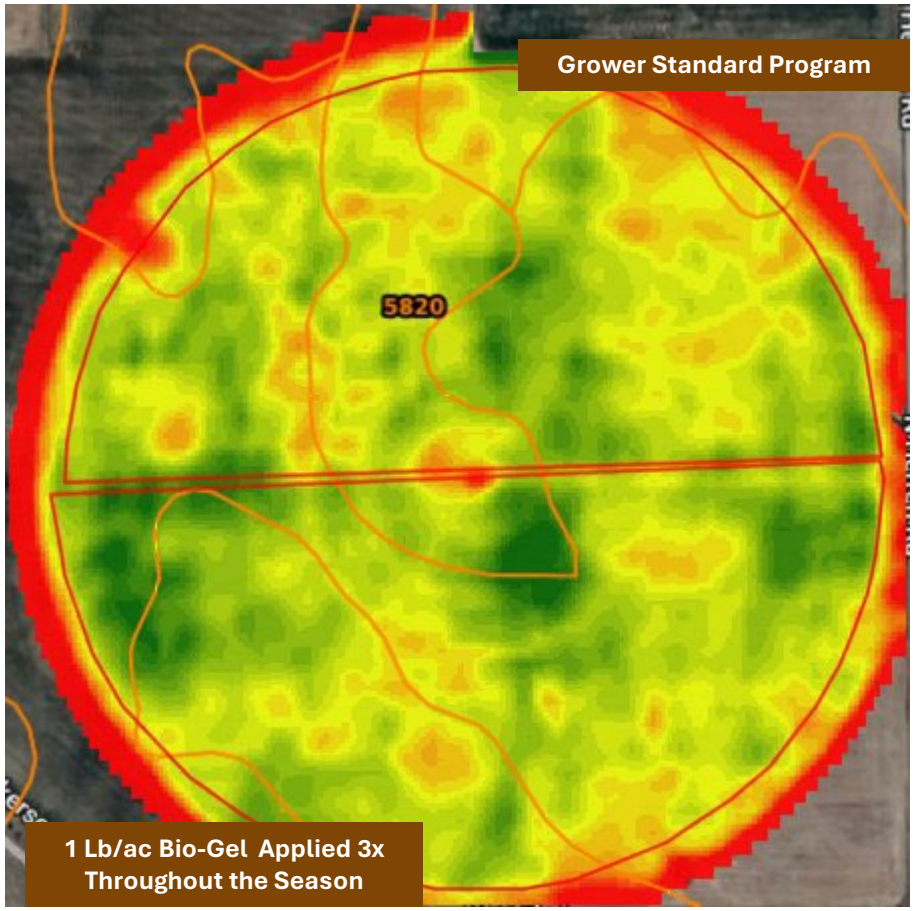


On farm trial locations

Bio-Gel®

Bio-Gel applied with UAN via sprinkler pivot reported a 77% increase in nitrate nitrogen at the Kansas Experimental Site





- Bio-Gel dry granular was tank mixed with each pass of UAN fertigated via overhead pivot
- Data suggests grower could position Bio-Gel as an expense reduction strategy, lowering the applied rate of UAN with the inclusion of Bio-Gel

Bio-Gel®

Bio-Gel reported observed changes in field residue and brace root development

Control - #9

Treatment - #8

Bio-Gel®

Control - #15

Treatment - #16

Bio-Gel®

Treatment 2,8,6

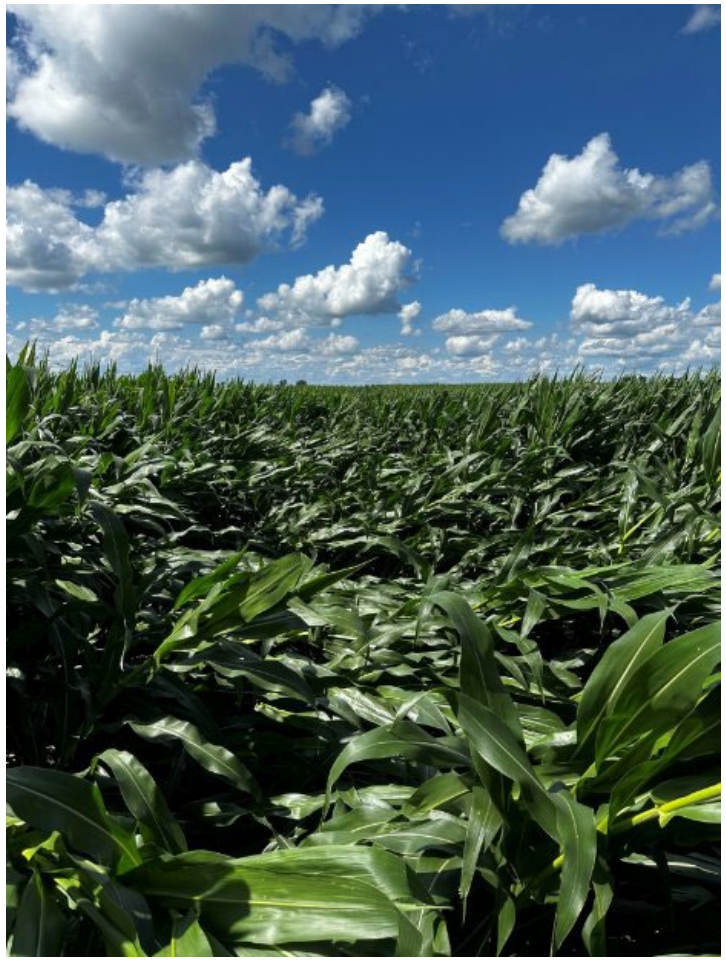
Control 15, 9, 11

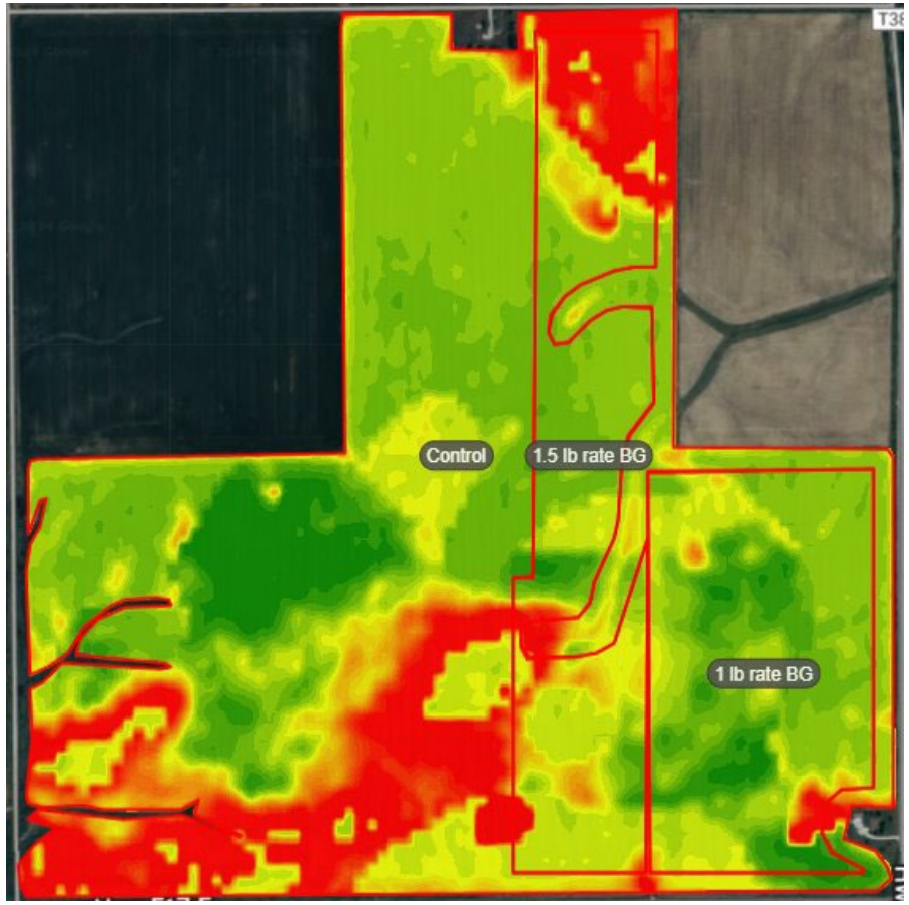
Treatment 2, 8, 6

Control 15, 9, 11

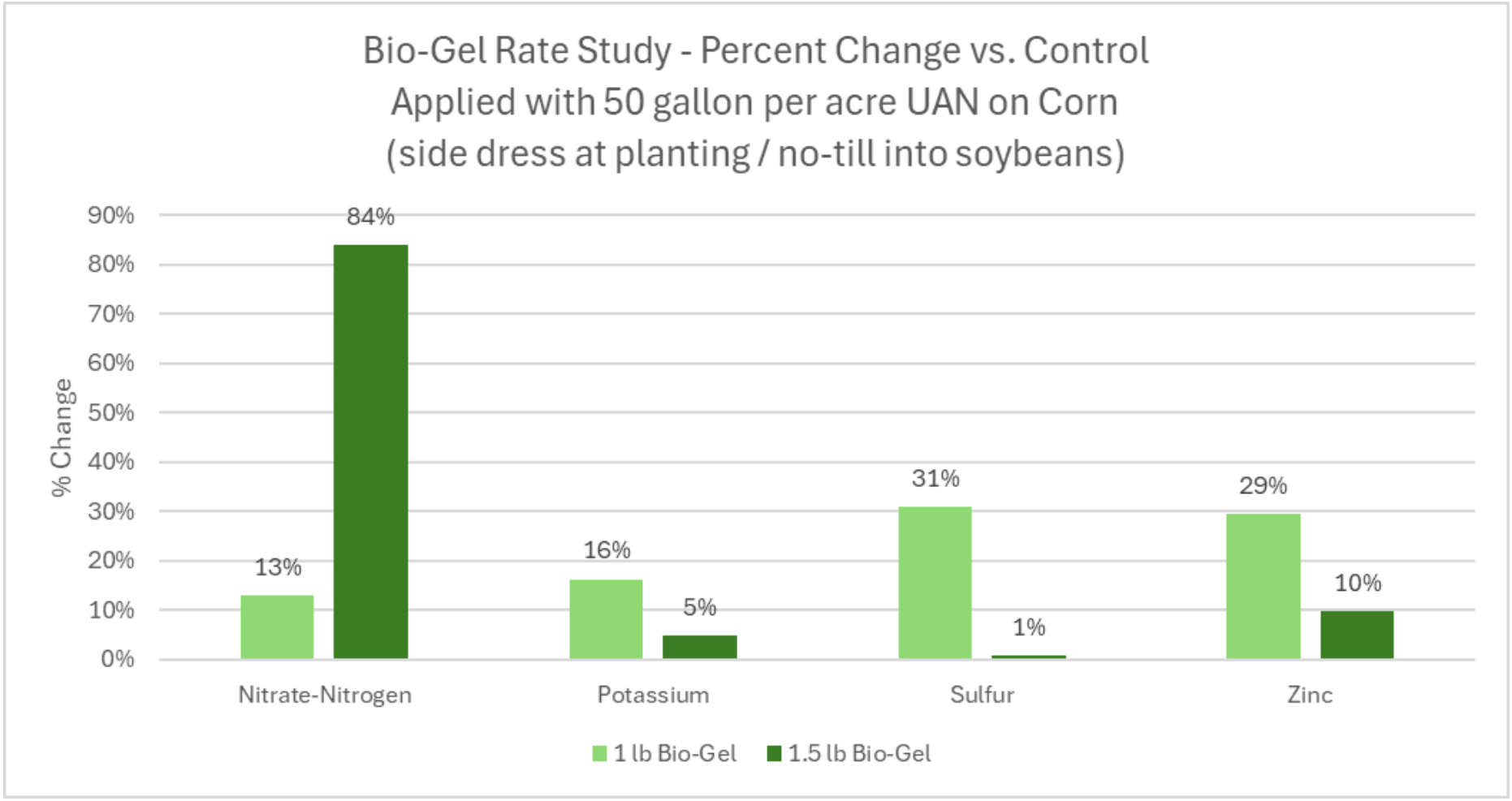
Bio-Gel®

Bio-Gel Rate Study in Iowa experienced uplifts in soluble nutrients when sampled July 15th, 2024. Prior to sampling – high winds reported field damage in control zone





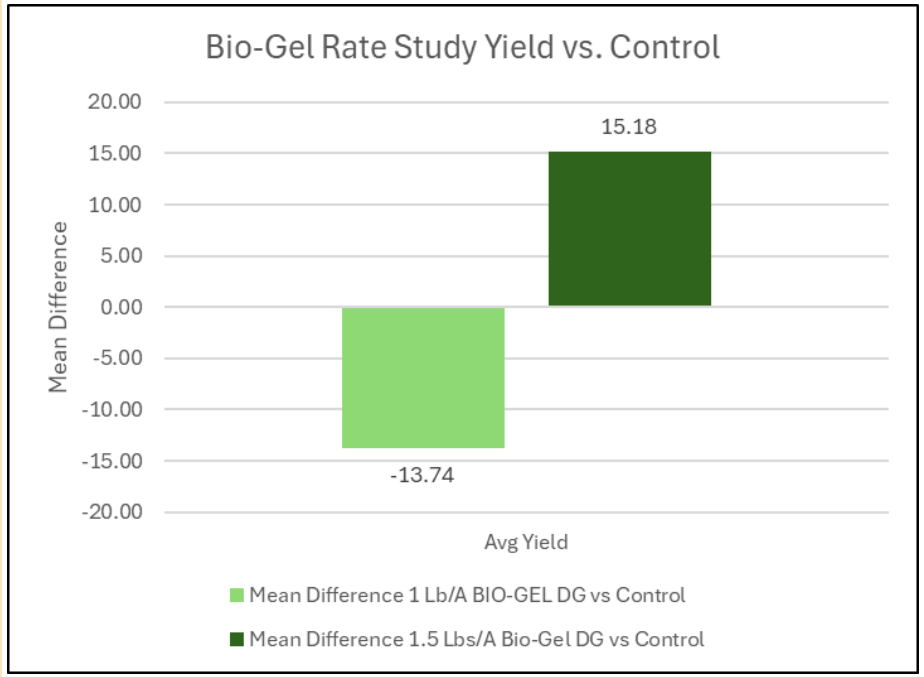
Bio-Gel®


Bio-Gel Rate Study - Percent Change vs. Control
Applied with 50 gallon per acre UAN on Corn
(side dress at planting / no-till into soybeans)
% Change
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
13%
84%
16%
5%
31%
1%
29%
10%
Nitrate-Nitrogen
Potassium
Sulfur
Zinc
1 lb Bio-Gel
1.5 lb Bio-Gel

Bio-Gel®

Bio-Gel increased yields +15 bpa at high rates of application

– however, yields likely impacted by early season wind damage



Bio-Gel®

Bio-Gel rate study in IA reported uplifts in yield with increases in Bio-Gel application rate

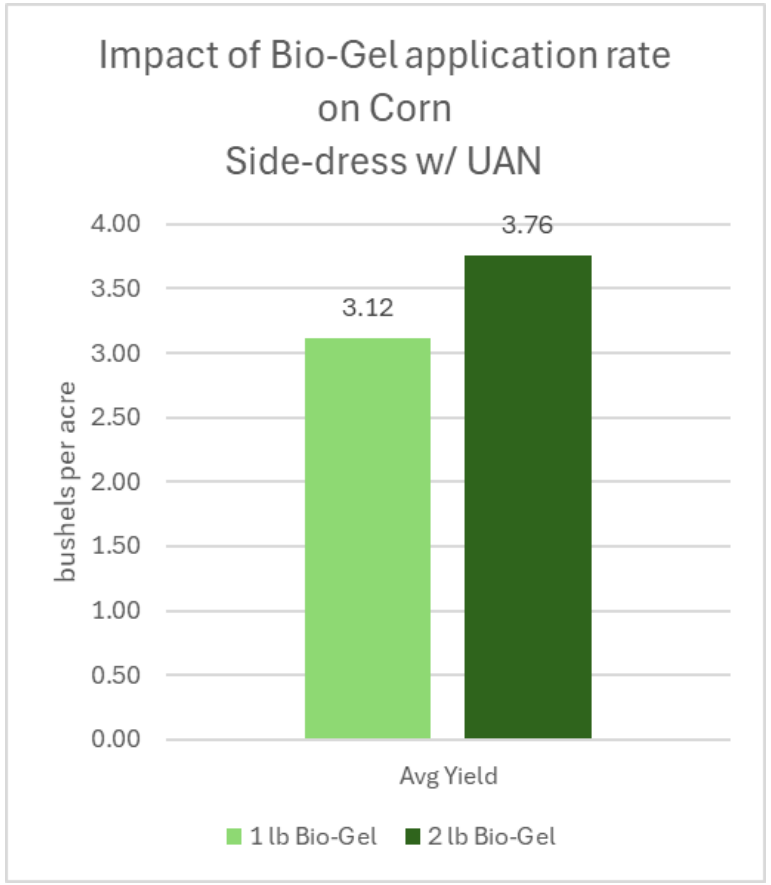
Planting Date: 4/26/24

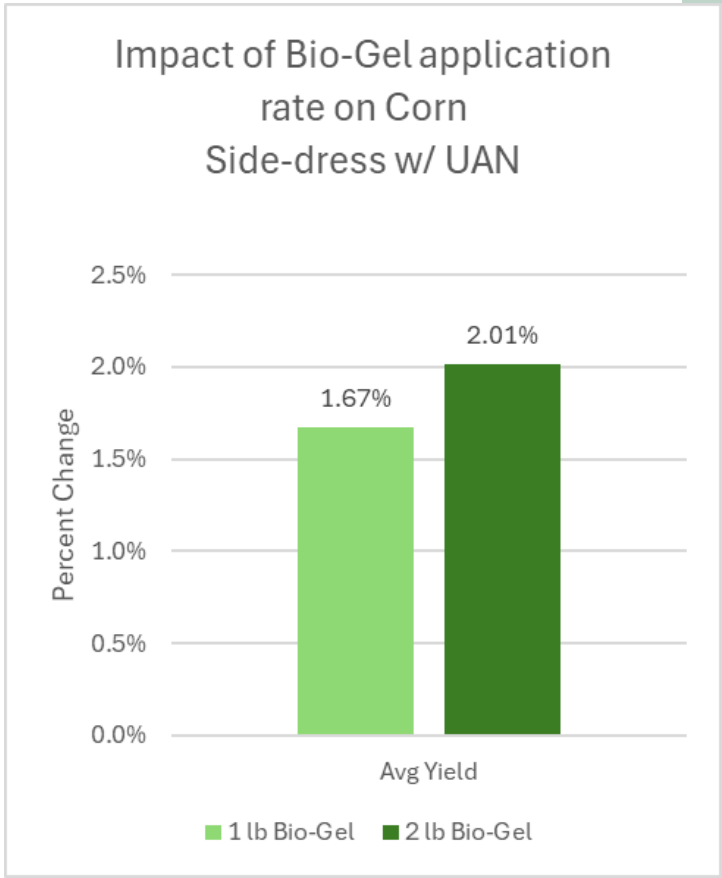
Grower Standard Dry Fertilizer
- 50 Lbs/A DAP
- 75Lbs/A Pel Lime
- 150 Lbs/A Cal Sul
- 1 Lb/A Boron

2X2
- 4 Gal/A 7-21-3
- 4 Gal/A UAN 28%

Spray Pre-emerge 5/2/24:
- 20 Gal/A UAN 28%
- 6 Gal/A LCBF BOOST

Side-Dress:
- 20 Gal/A UAN 28%
- 2 Gal/A LCBF Boost
- 5 Gal/A ATS
- **1 lb / 2 lb Bio-Gel**

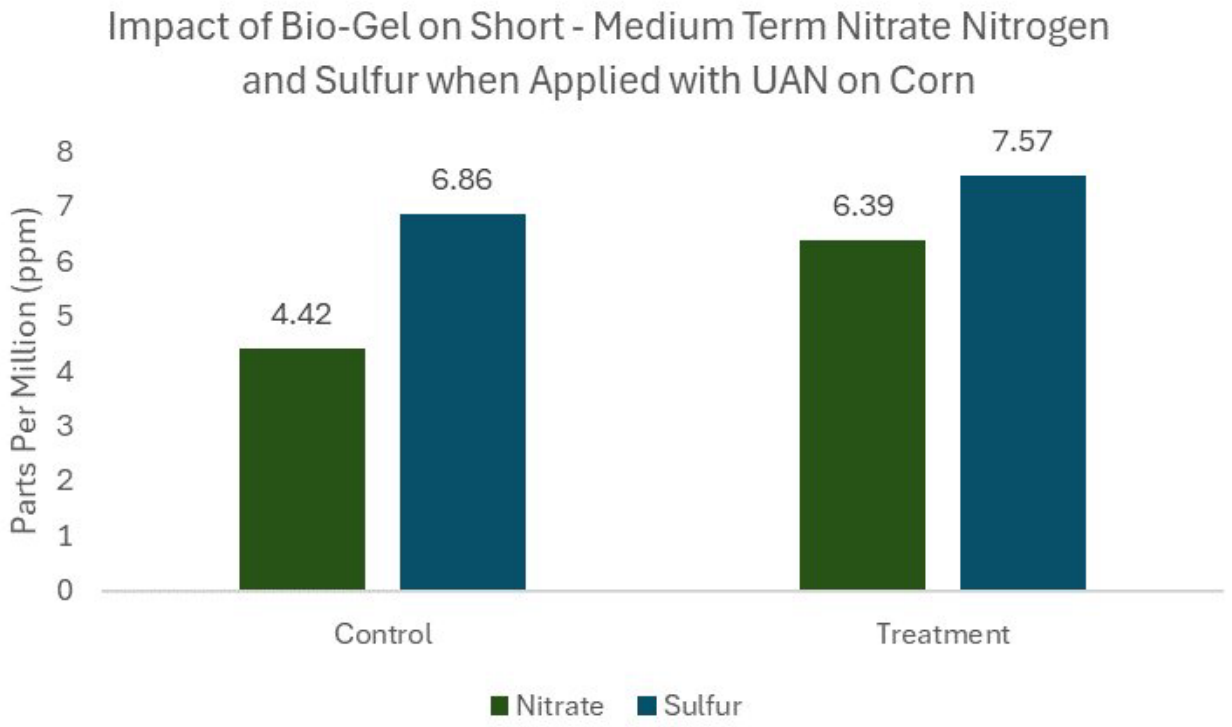




Midwestern BioAg™

When applied with UAN, Bio-Gel Increased Nitrate Nitrogen 44% (short-med term) and Increased Sulfur 10%

- Less statistically significant but notable for context.
- Statistically variability may be due to the wide range of application rates of UAN observed in the grower standard program.
- Eleven soil types were sampled (n=71)



Bio-Gel®

Bio-Gel results on corn yield

Improved cob fill and reduced tip back were observed in Iowa corn trials

Estimated ***+40 bpa uplift***

Bio-Gel®

With the use of Bio-Gel, there was an estimated 10% improvement in nutrient use efficiency based on nitrate nitrogen and soil organic carbon increases

EXPENSE REDUCTION

Input Requirements for UNL Nitrogen Demand Algorithm			
	Expected Yield	*Soil Nitrate (ppm)*	*Organic Matter (%)*
Control	230	4.42	2.86
Bio-Gel	230	6.39	3.13

Nitrogen Fertilizer Required to Meet Expected Yield		
	Pounds Per Acre	*Nitrogen Use Efficiency*
Control	183.5	0.80
Bio-Gel	159.1	0.69

REVENUE POTENTIAL

Input Requirements for UNL Nitrogen Demand Algorithm			
	Expected Yield	*Soil Nitrate (ppm)*	*Organic Matter (%)*
Control	230	4.42	2.86
Bio-Gel	262	6.39	3.13

Nitrogen Fertilizer Required to Meet Expected Yield		
	Pounds Per Acre	*Nitrogen Use Efficiency*
Control	183.5	0.80
Bio-Gel	183.5	0.70

*Based on calculations of University of Nebraska-Lincoln nitrogen demand algorithm

Bio-Gel®

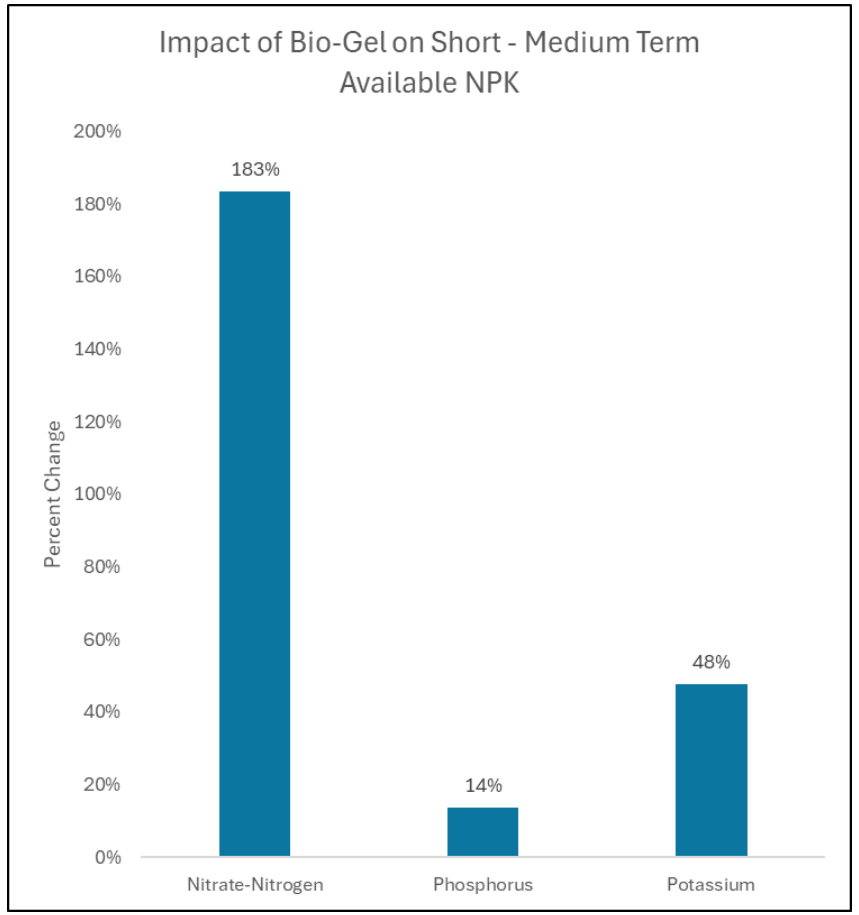
Bio-Gel increased soluble NPK when dry blended with grower standard fertility program

Bio-Gel Dry granular (2 pounds per acre) was dry blended with GSP and VRT spread ahead of soybeans

Grower Standard

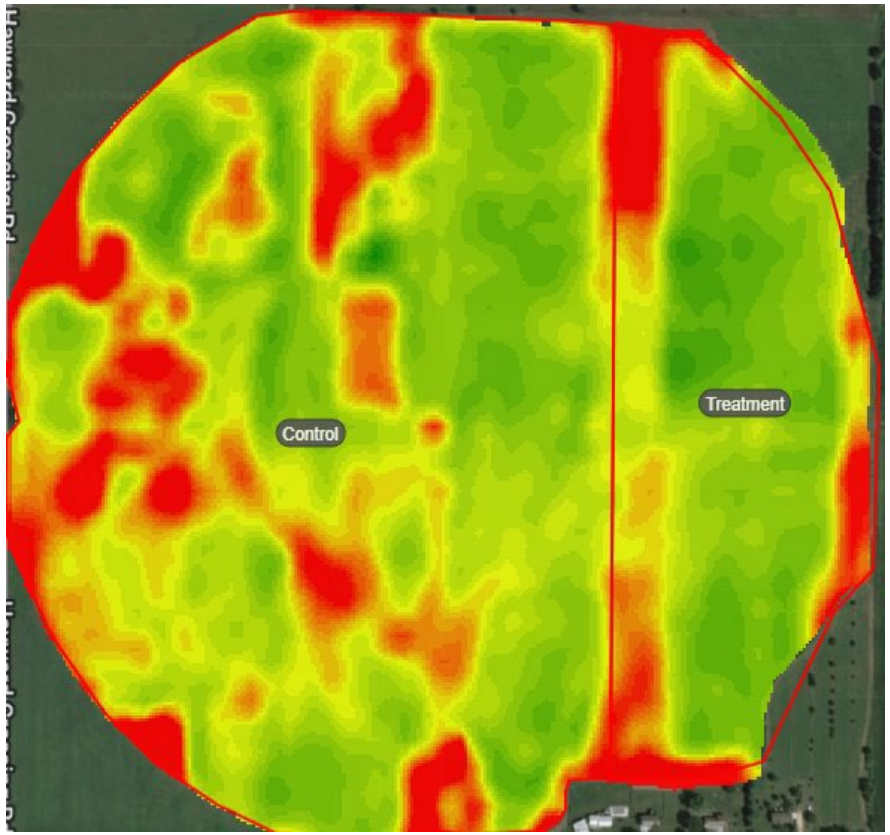
88.5 pounds per acre AMS

132.6 pounds per acre Potash

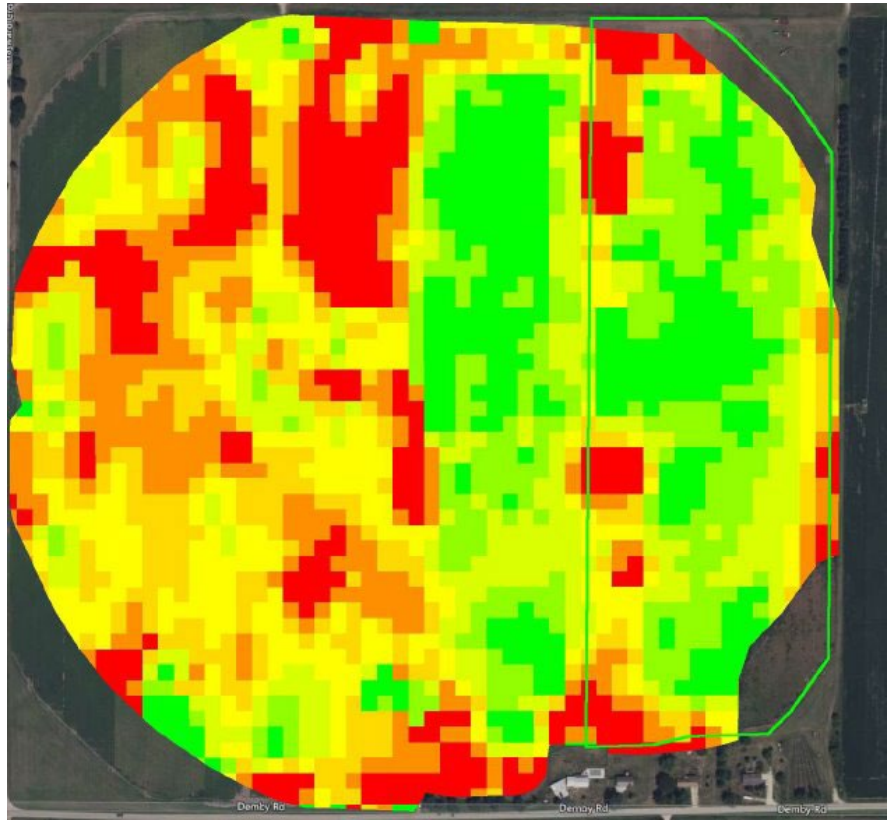


Bio-Gel®

Bio-Gel *increased yields 5 bpa* – average yield in treatment zone 87.3 bushels per acre



NDVI captured September 4th, 2024

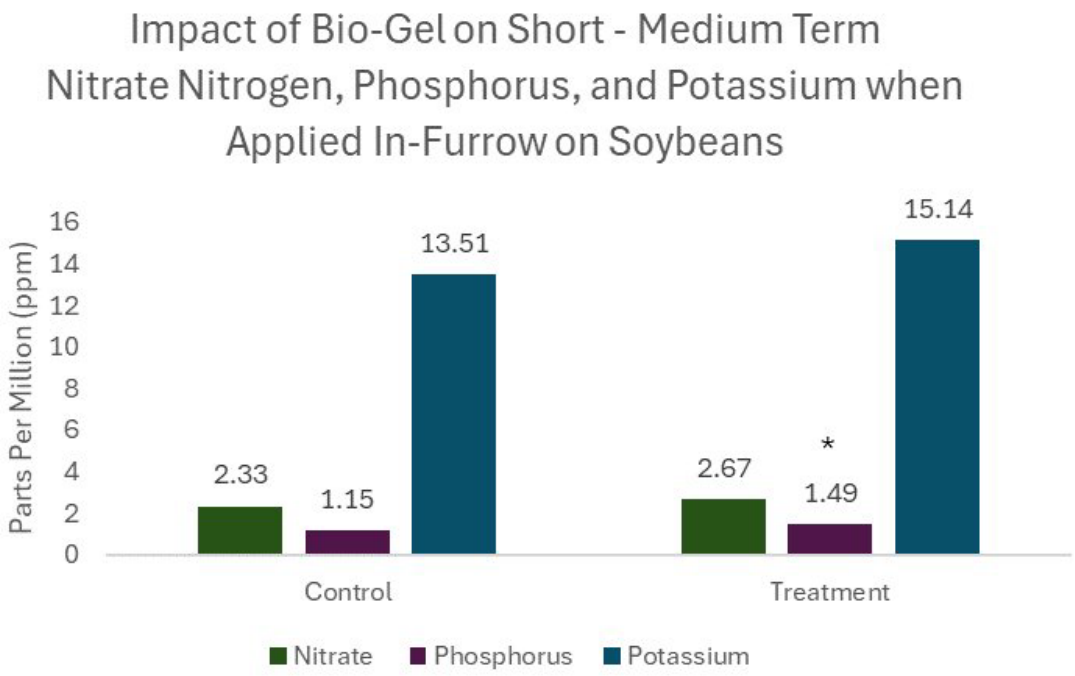


Yield

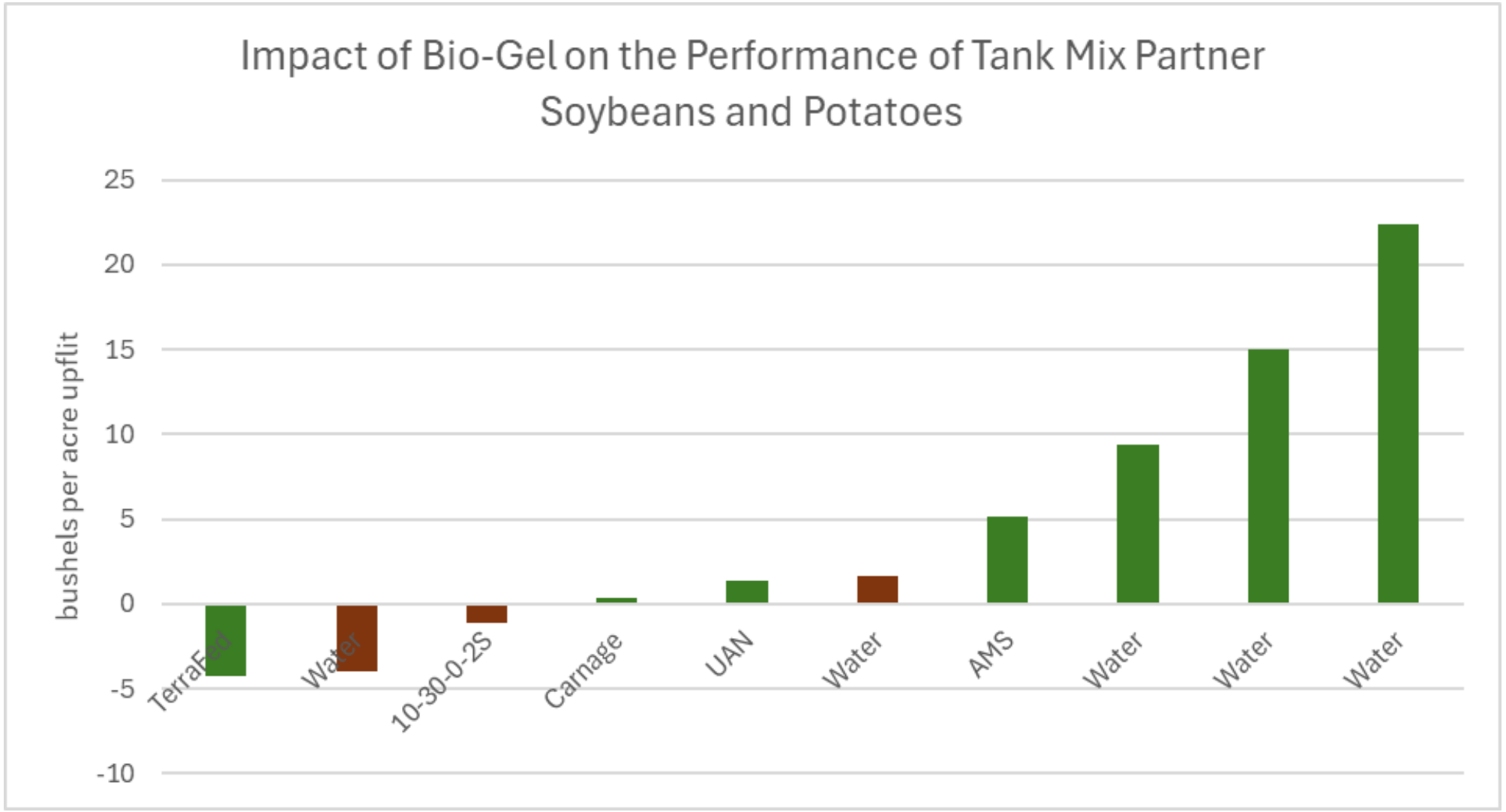
Bio-Gel®

Bio-Gel increased short - medium term available phosphorus 30% when applied as an in-furrow starter with GSP (98% confidence)

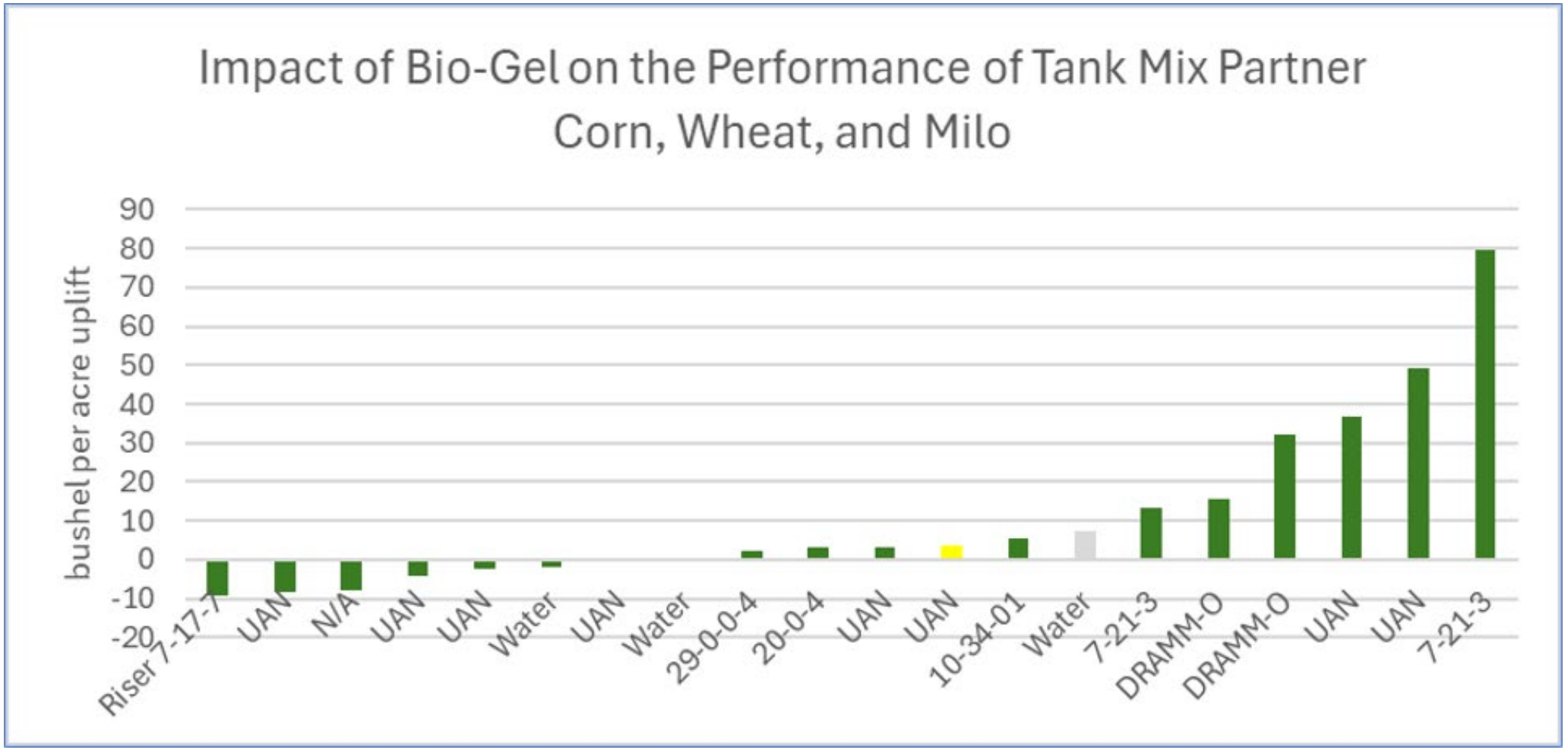
- Experimental sites were in ND, SD and WI
- Treatments included both Bio-Gel Dry Granular and Bio-Gel LC
- 28 samples were collected 30 – 45 days after planting
- Samples collected across 7 soil types predominantly sand – silt loams



Bio-Gel®

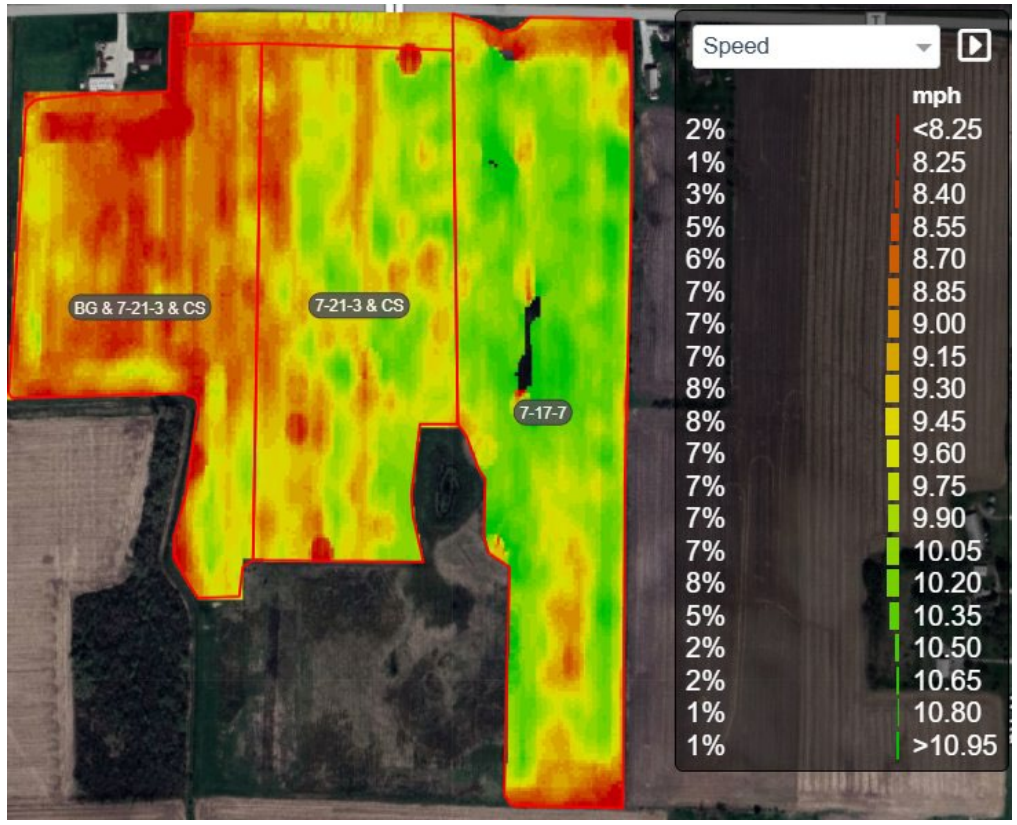

Impact of Bio-Gel on the Performance of Tank Mix Partner
Soybeans and Potatoes
bushels per acre upflit
25
20
15
10
5
0
-5
-10
TerraFed
Water
10-30-0-2S
Carnage
UAN
Water
AMS
Water
Water
Water

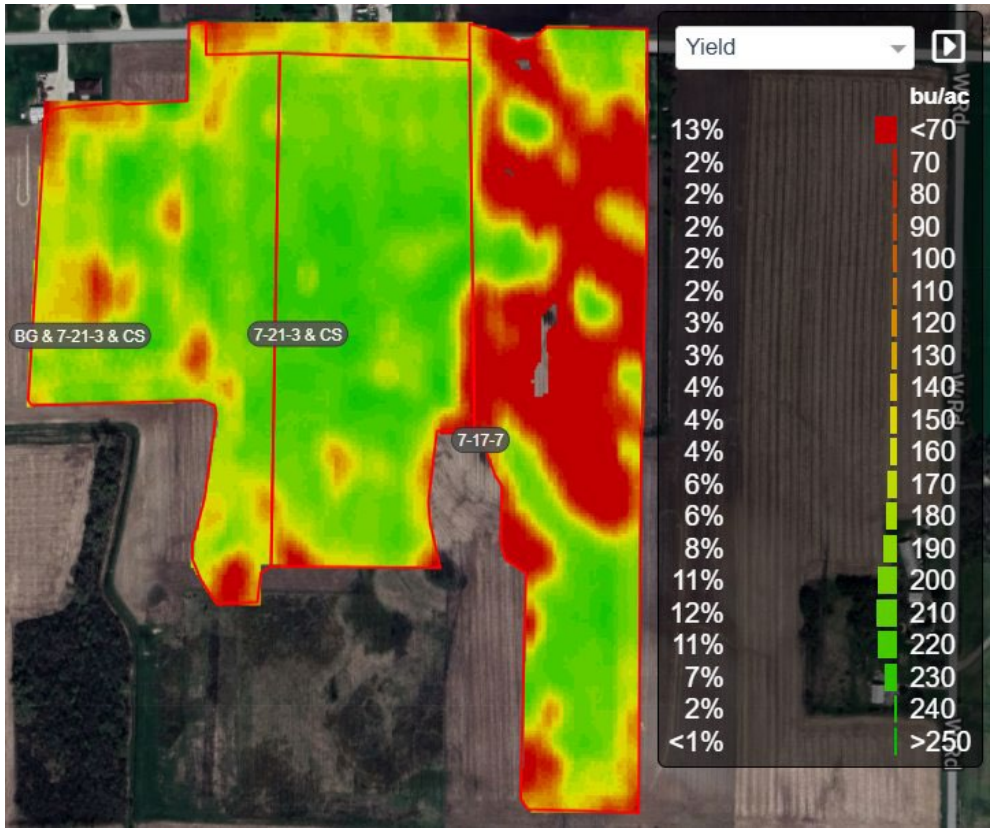
Bio-Gel®


Impact of Bio-Gel on the Performance of Tank Mix Partner
Corn, Wheat, and Milo
bushel per acre uplift
90
80
70
60
50
40
30
20
10
0
-10
-20
Riser 7-17-7
UAN
N/A
UAN
UAN
Water
UAN
Water
29-0-0-4
20-0-4
UAN
UAN
10-34-01
Water
7-21-3
DRAMM-O
DRAMM-O
UAN
UAN
7-21-3

Bio-Gel®

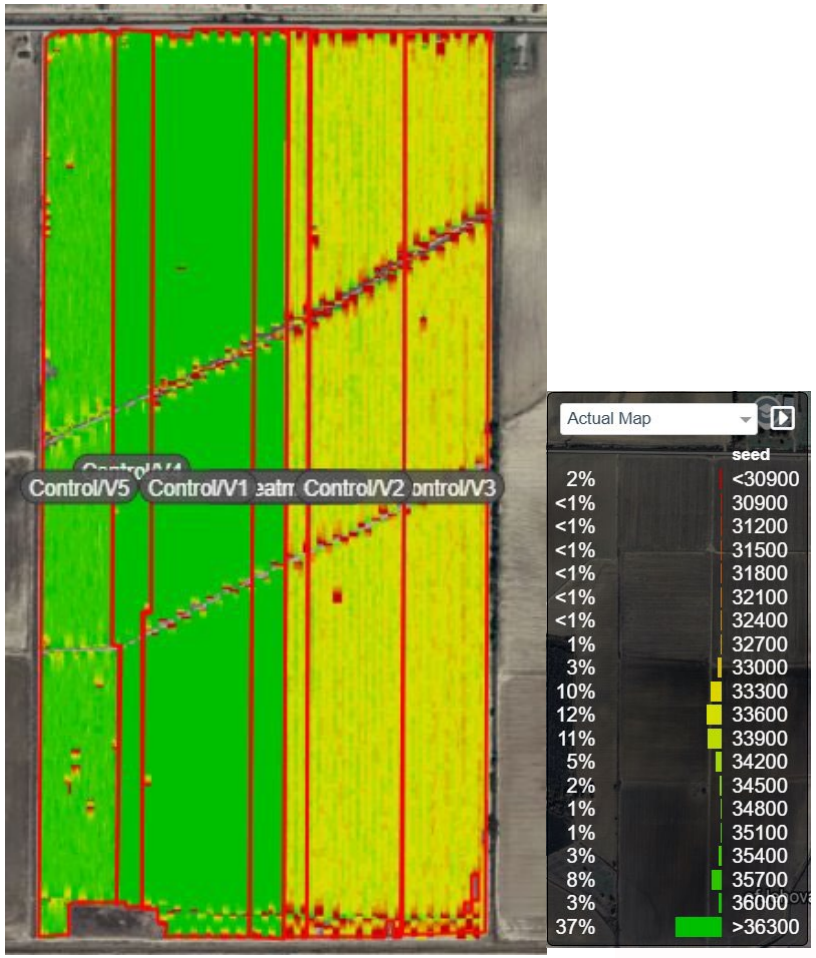
High yield responses with Bio-Gel and liquid carbon-based fertilizers were reported in Wisconsin

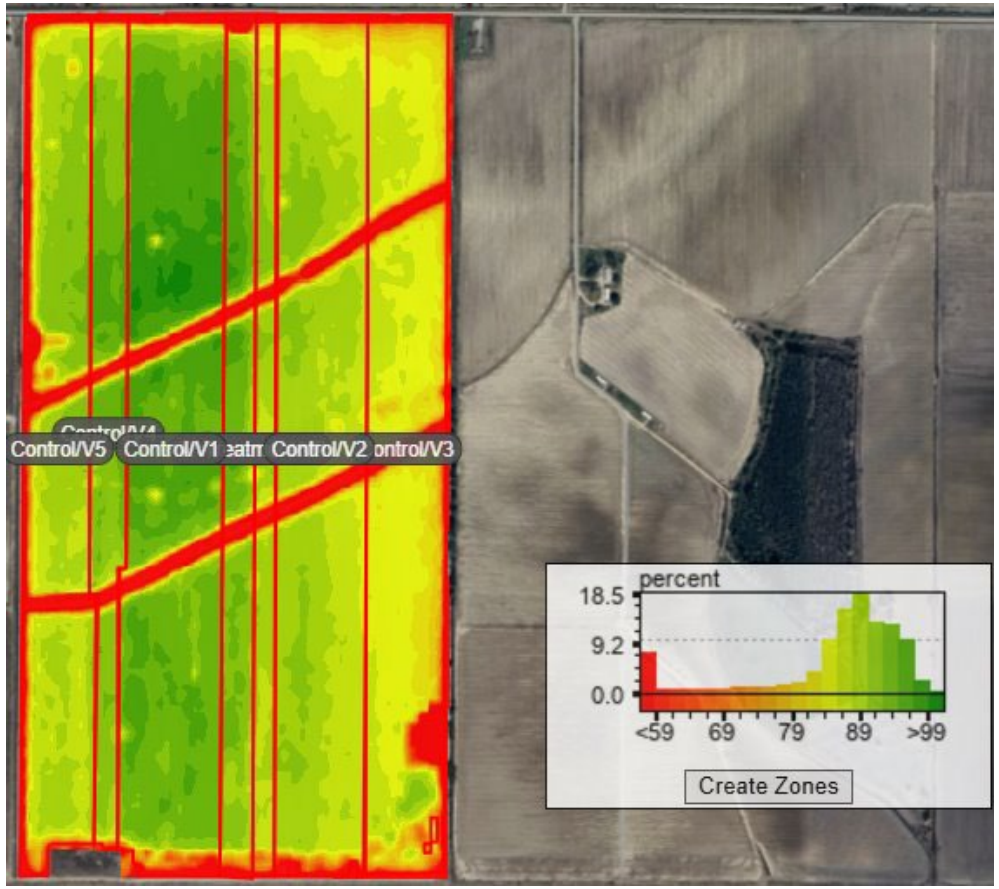




Bio-Gel®

Multi-variety corn trial reported yield reductions -.5 and -12.4 bpa when applied with UAN - however planting populations likely impacted yields





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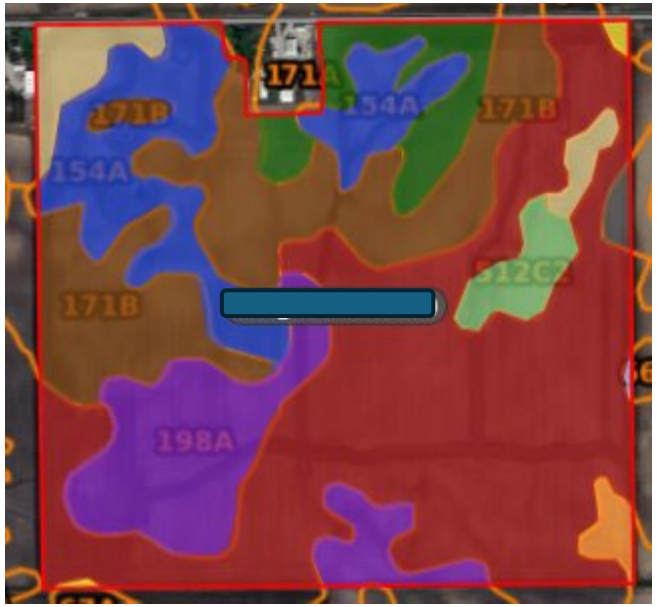
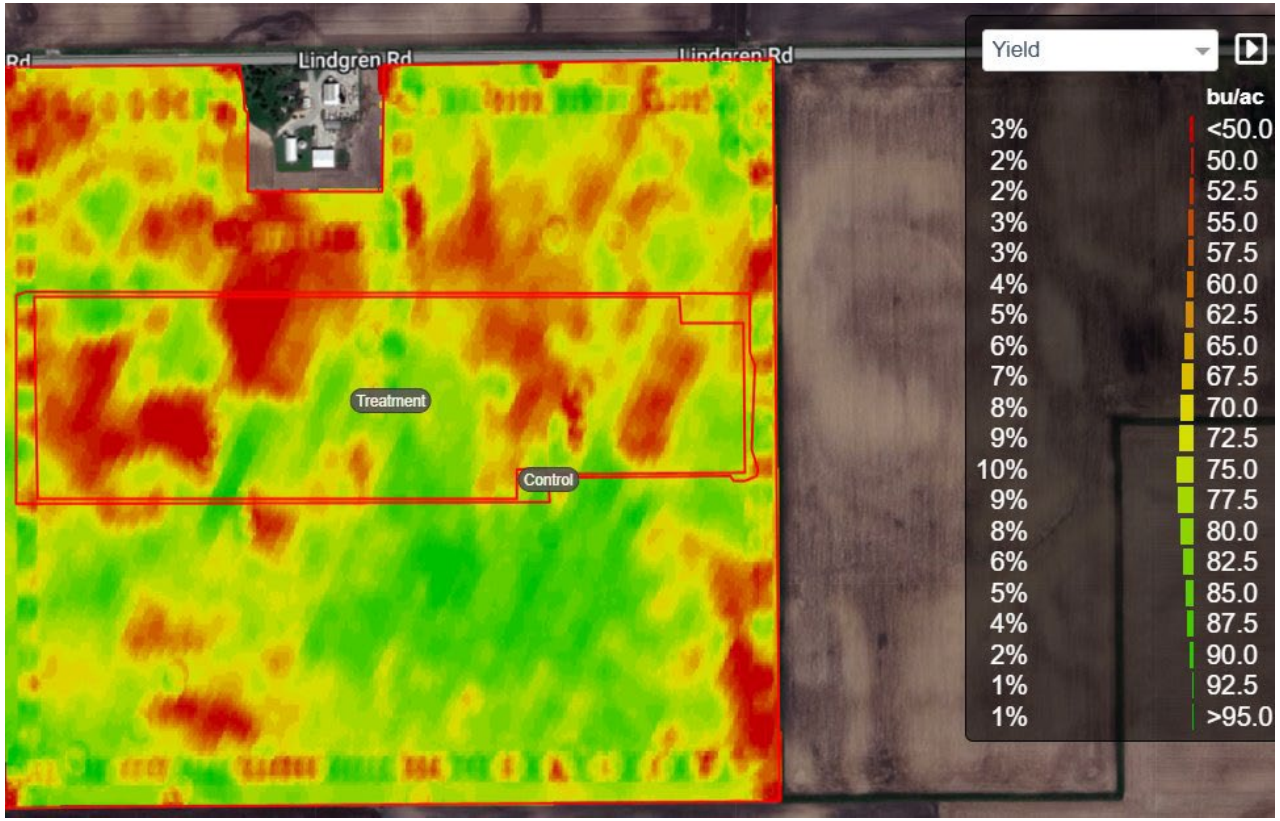
Foliar Soybean trials applied 6/18/24 reduced yield -.26 and - -8.5 bpa

Treatment

1 lb/ac Bio-Gel Dry Granular

10 gal/ac water





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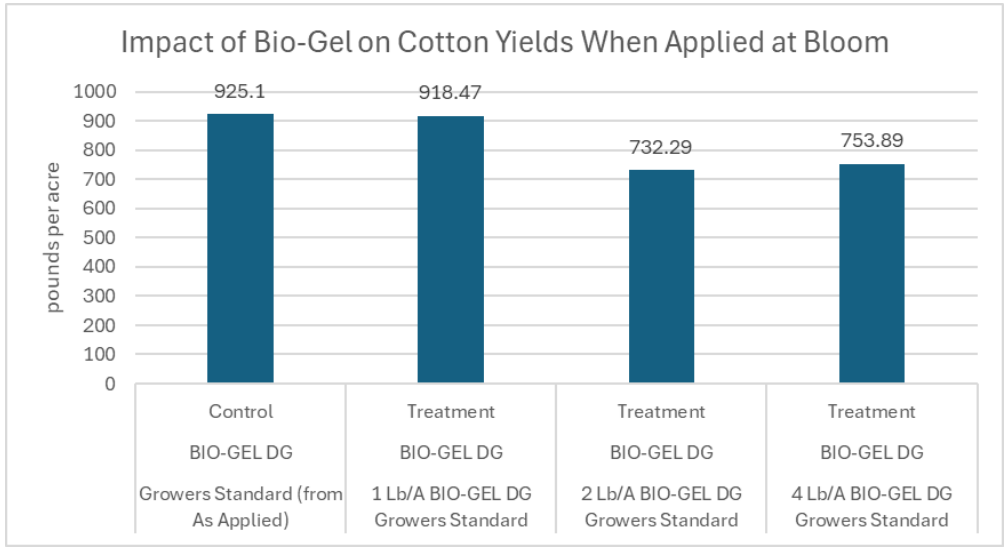
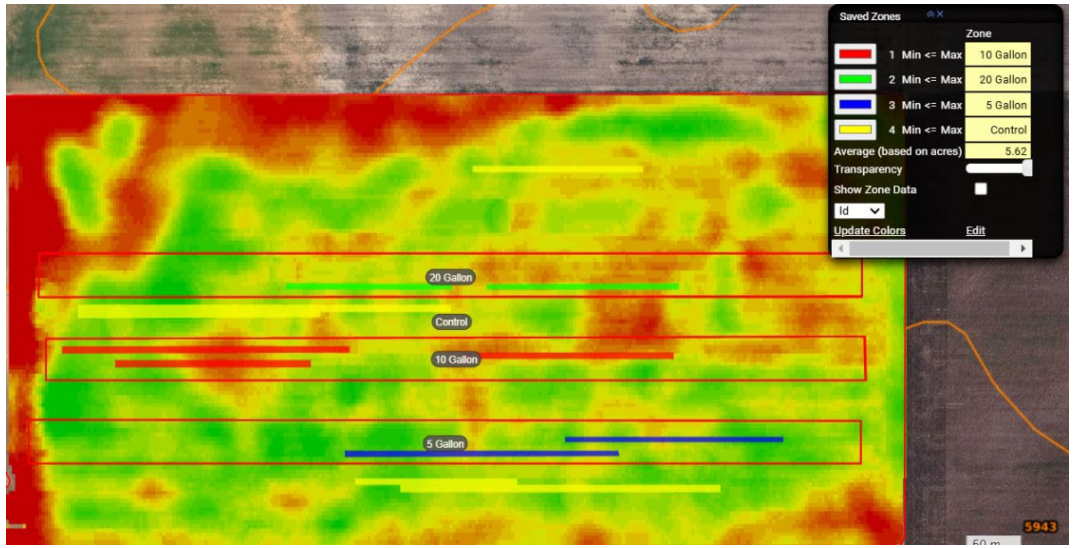
Bio-Gel rate study applied on Cotton 54 days after planting reported yield loss at higher rates of application





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