

Making Data-Driven Decisions on Soybean Inoculations in Nebraska Cropping Systems

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Introduction



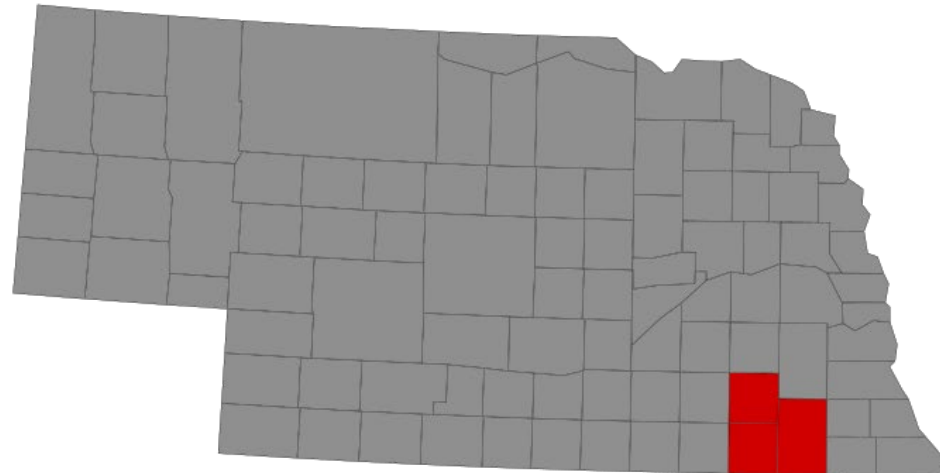
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Crop Production Clinic – Mead, Jan. 15

Resources from today posted online at agronomy.unl.edu/cpc

Nebraska Extension's Expertise and Personnel Directory

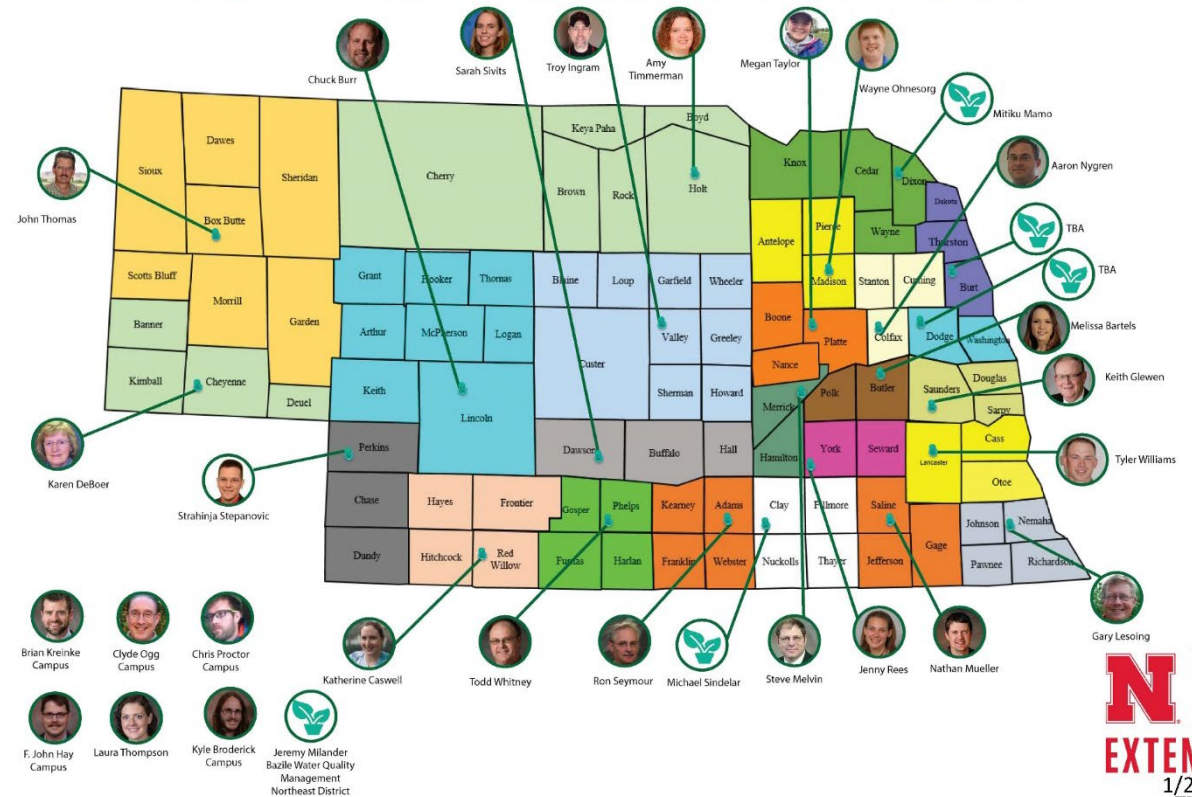
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Cropwatch

Central resource for University of Nebraska–Lincoln Extension information on crop production and pest management.

cropwatch.unl.edu

INNOVATIVE CROPPING & WATER SYSTEMS ACCOUNTABILITY REGIONS



Goals for Us

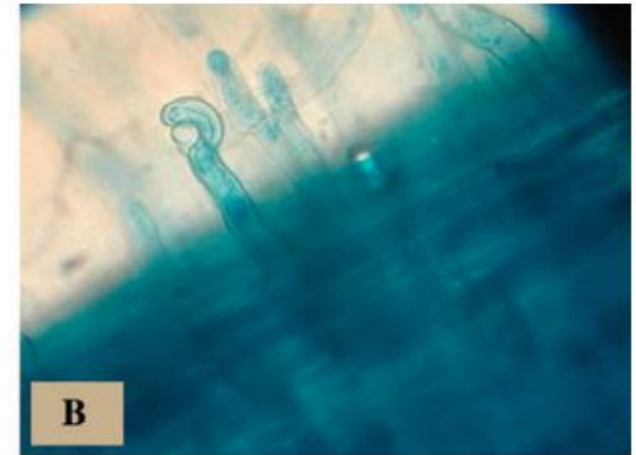
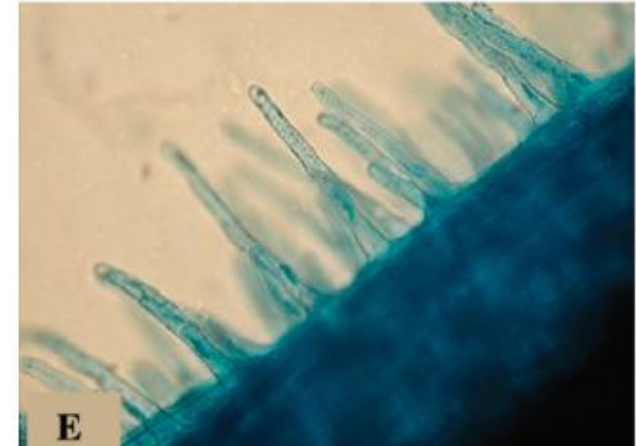
- Understand biological nitrogen fixation in soybeans
- Learn how to place fields into categories of probability of yield response
- Use data to guide your decision

Based on the following article:

cropwatch.unl.edu/2017/making-data-driven-decisions-soybean-inoculation

Understanding the start of biological nitrogen fixation

- Species in the United States
 - *Bradyrhizobium japonicum*
 - *Bradyrhizobium elkanii*
- Bacteria attach to soybean roots (E) in response to attractants exuded by the roots, mainly flavonoids
- Bacteria-to-plant signal molecules or Nod factors cause soybeans to respond by root-hair curling (B) or deformation and eventually resulting in complete nodule structure
- Process sensitive to abiotic stresses (pH, salinity, etc.)



Source: Duzan et al., 2004. Perceptions of *Bradyrhizobium japonicum* Nod factor by soybean root hairs under abiotic stress conditions. *Journ of Experimental Botany*. 55 No. 408 pp. 2641-2646

Other interest facts

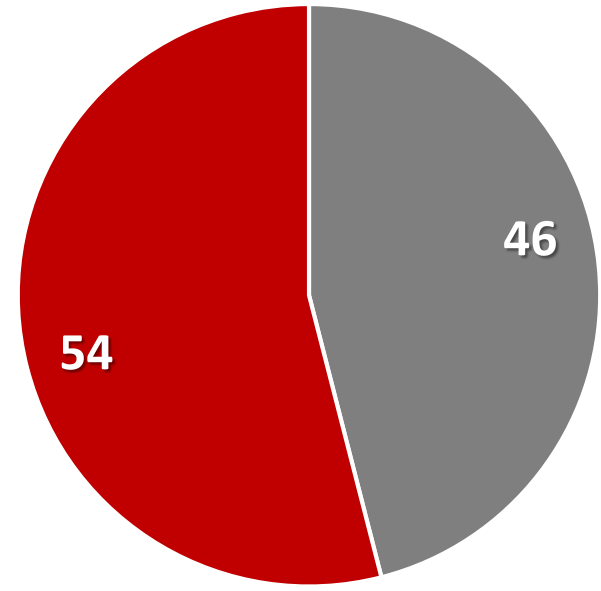
- The process of fixing nitrogen in the soil air to ammonia occurs through the symbiotic relationship between soybeans and the *Bradyrhizobium* species, bacteria within the nodules of soybean roots. Bacteria get carbohydrates in return.
- The symbiotic bacteria *Bradyrhizobium j.* can survive long periods of time as a saprophyte over 20 years.
- Bacteria not very mobile in soil – once study showed movement of only 150 feet over a 20 year period.
- Nodules can start to form on root hairs immediately, but nitrogen is not fixed until the V3-V4 growth stage.



Soybean Yield = 70 bu/ac

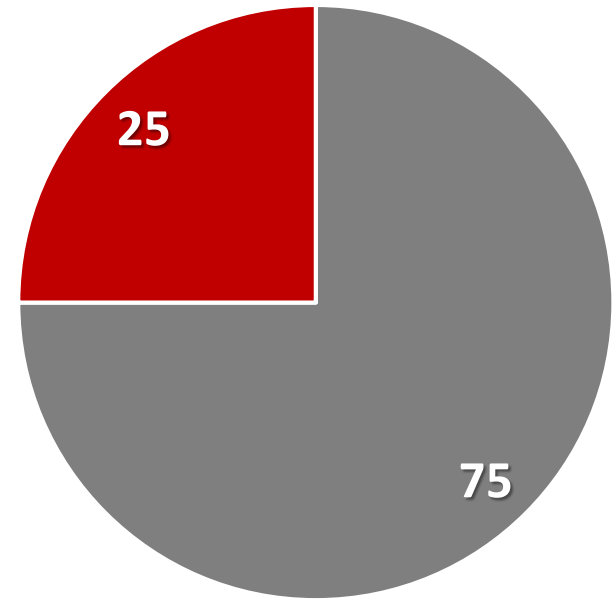


Nitrogen Uptake (330 lbs N)



■ Fixation ■ Soil

Nitrogen Uptake (330 lbs N)

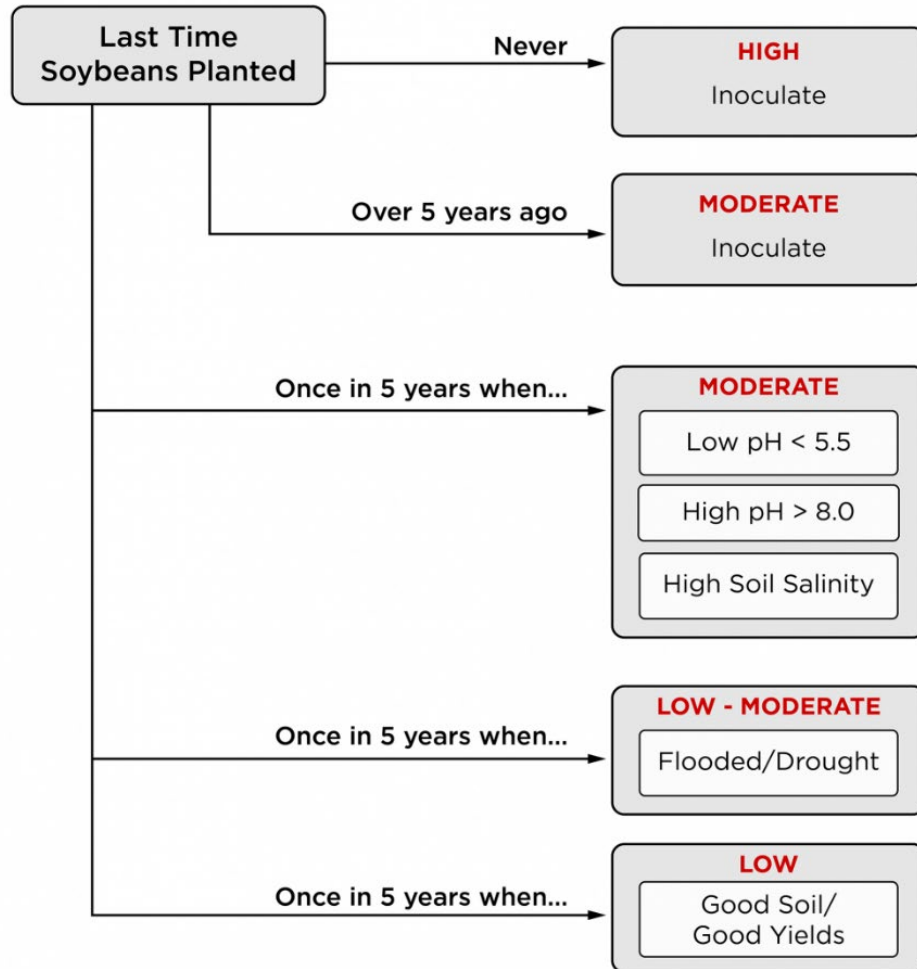


■ Fixation ■ Soil

Inoculation Decision Tree

Inoculation Decision Tree

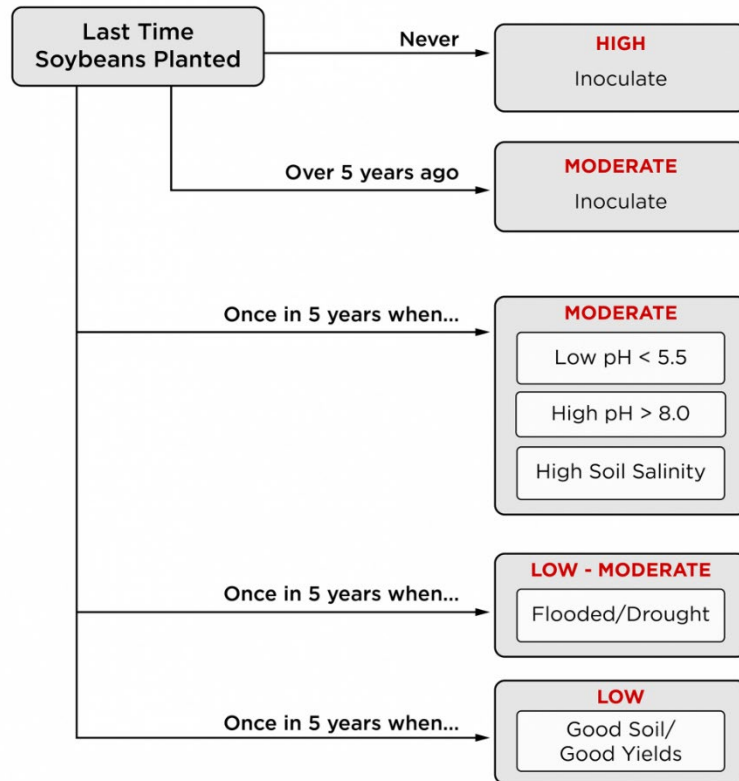
LOW, **MODERATE** and **HIGH** probability of a yield response to inoculation.



High Probability of Response

Inoculation Decision Tree

LOW, MODERATE and HIGH probability of a yield response to inoculation.

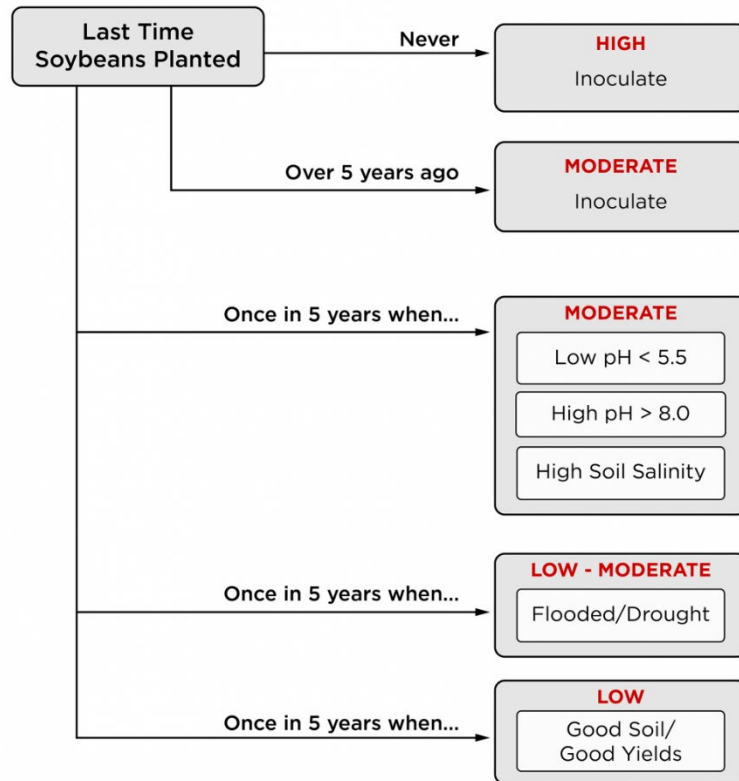


- No history – not many fields left
- 49 bpa response in Nebraska back in 1980s
- 1 to 10 bpa expected
- Degree of yield response dependent on soil nitrogen supply & inoculation success
- Rates (1x, 2x, multiple products)?

Moderate Probability of Response

Inoculation Decision Tree

LOW, **MODERATE** and **HIGH** probability of a yield response to inoculation.

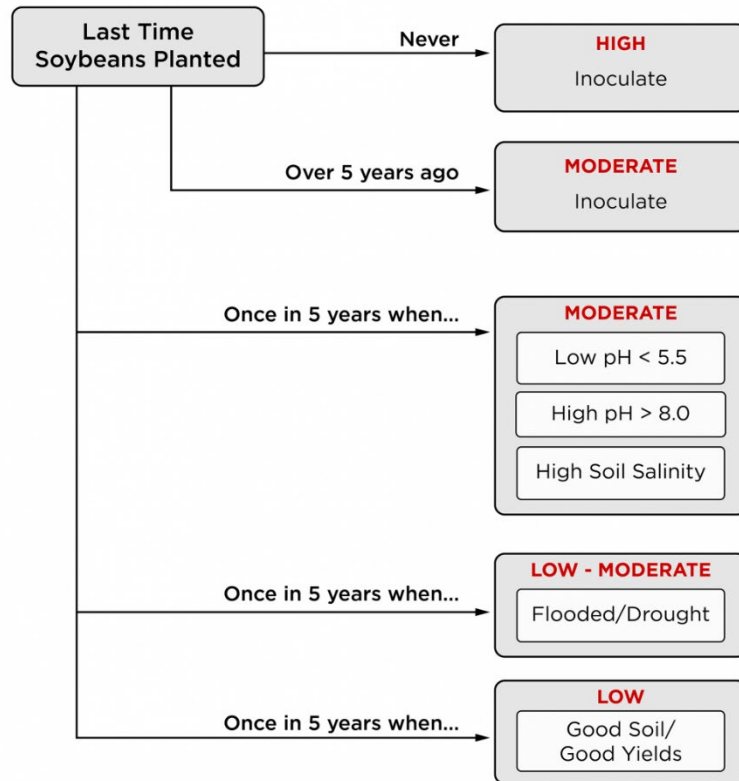


- After alfalfa, continuous corn, CRP
 - 2 bpa after continuous corn in Wisconsin
 - 2 bpa after pasture/CRP for 20+ years in Iowa

Low-Moderate Probability of Response

Inoculation Decision Tree

LOW, **MODERATE** and **HIGH** probability of a yield response to inoculation.

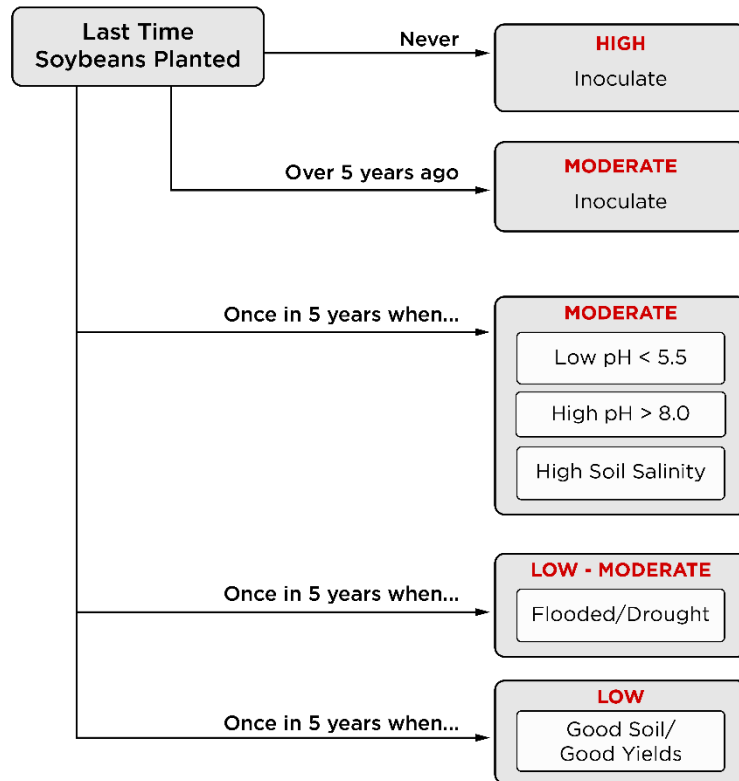


- Non-optimal soil pH
- Low pH - decrease in root hair modification... lime
- High pH – decrease nodulation, fixation, survival
- High soil salinity
- Flood-damaged fields
- Droughts and soil textures

Low Probability of Response

Inoculation Decision Tree

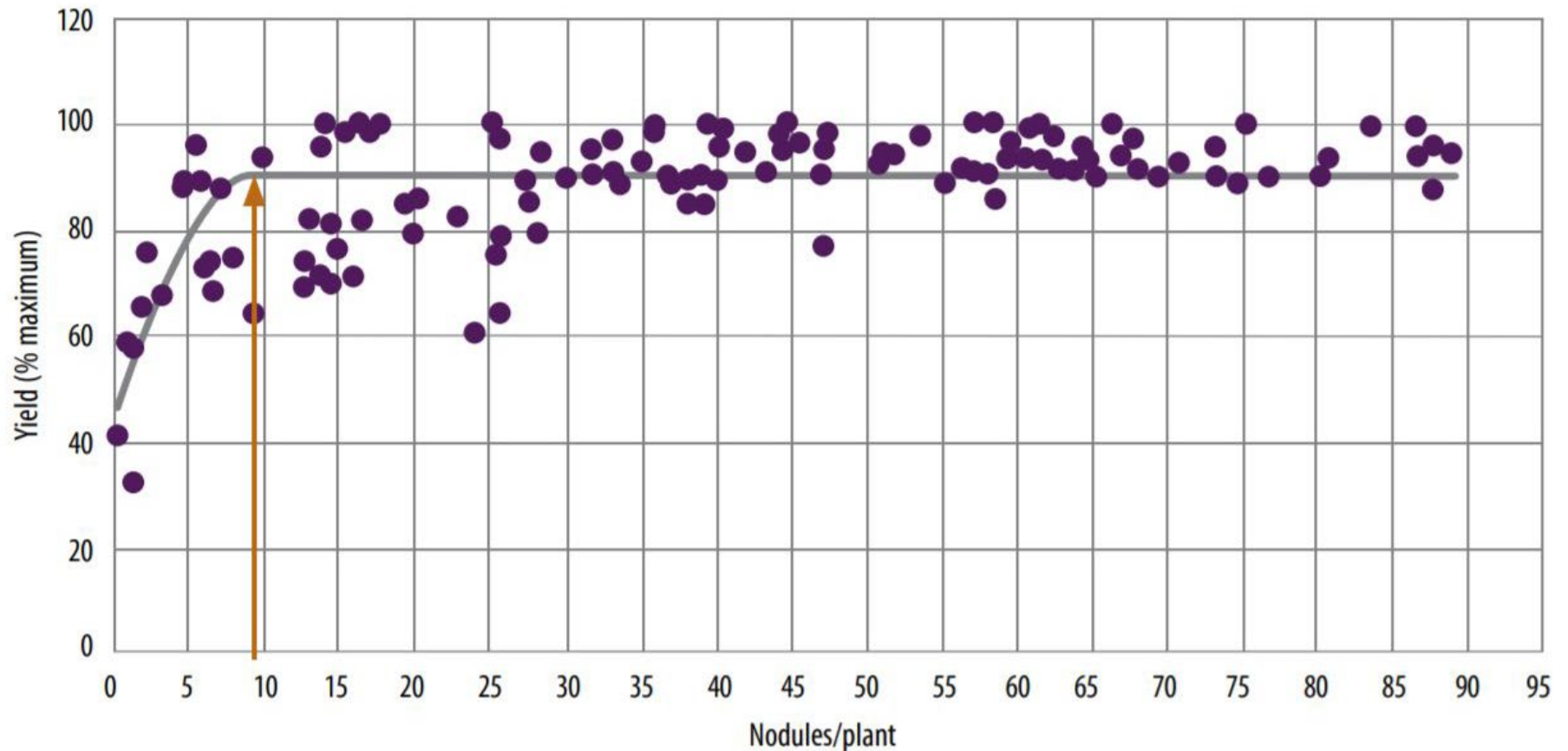
LOW, **MODERATE** and **HIGH** probability of a yield response to inoculation.



- Soybeans in rotation once every 5 years or more frequently & good soil conditions
- 8-yr study 2000-2008 testing 51 products, 73 experiments in the Midwest = 0 bpa
- Can new effective nitrogen-fixing strains out compete indigenous strains?

What is well-nodulated?

Figure 1. Relationship between number of nodules at R4 per soybean plant and relative yield.



Source: <https://www.manitobapulse.ca/>

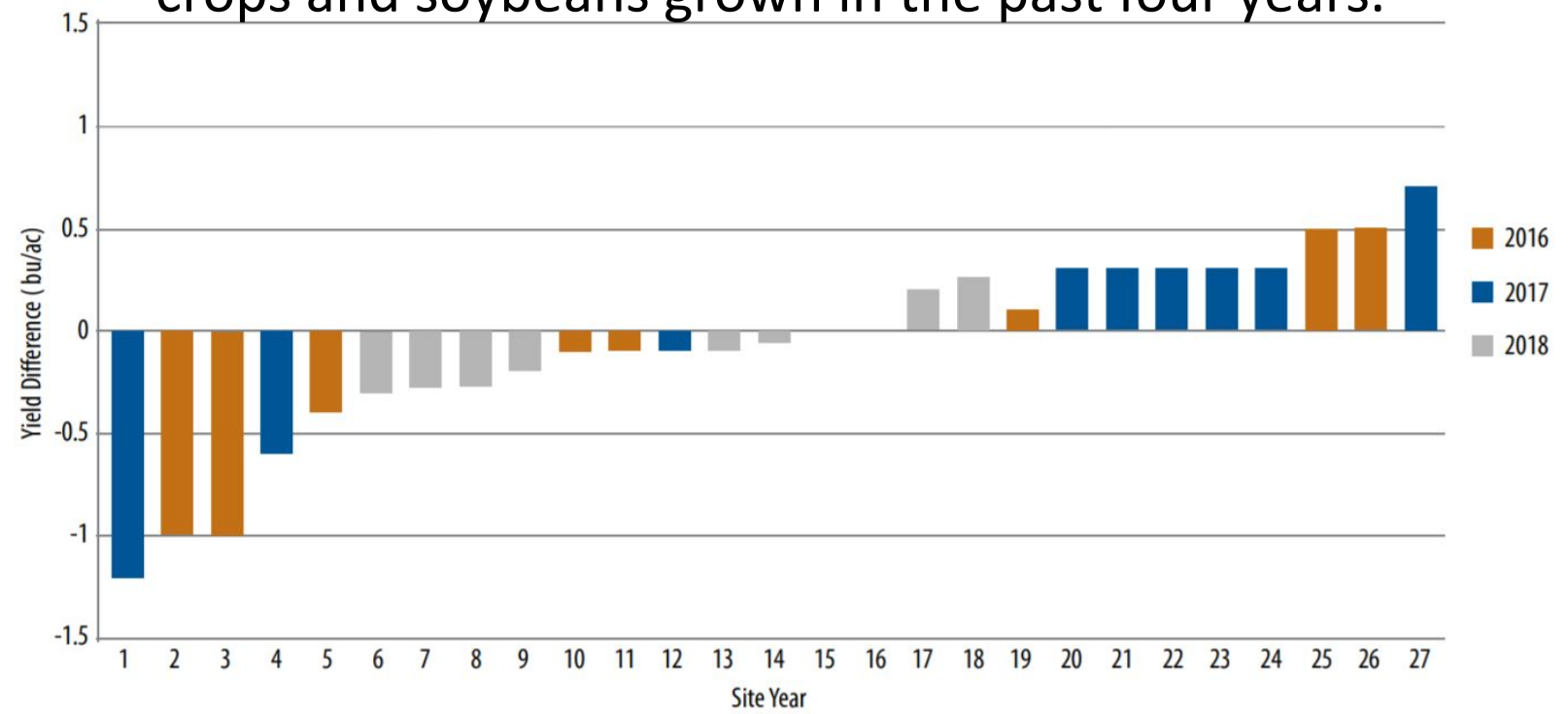


On-Farm Evaluations of Single Vs No Inoculation in Manitoba



All fields had at least three well-nodulated soybean crops and soybeans grown in the past four years.

Figure 1. Soybean yield difference between single and no inoculation at 27 sites from 2016 to 2018. No significant differences were present between sites.



No tool producers to determine rhizobium populations. Interest in developing a rapid soil test to determine levels of *B. japonicum*

Source: <https://www.manitobapulse.ca/>



Summary of Nebraska On-Farm Research on Soybean Inoculation



resultsfinder.unl.edu



Cost of products were \$0.44 to \$4.50/ac, includes numerous company products, both in-furrow and seed treatments



Summary of Nebraska On-Farm Research on Soybean Inoculation



Table 1. On-Farm Studies in Nebraska for Inoculation – Product minus untreated

Year	County	Product A/Product B	Yield Difference from Product A (bu/ac)	Yield Difference Product B (bu/ac)
1992	Lancaster	Accelerator/Liqiprep XT	-0.7	1.1
1998	Saunders	Standard/Urbana	0	0
1999	Saunders	Standard	0	
2001	Lancaster	Regular/CellTech	-1	-2
2001	Saunders	Magnify	0	

*Significant difference at the 90% confidence level

resultsfinder.unl.edu



Summary of Nebraska On-Farm Research on Soybean Inoculation



Table 2. On-Farm Studies in Nebraska for Inoculation – Product minus untreated

Year	County	Product A/Product B	Yield Difference from Product A (bu/ac)	Yield Difference Product B (bu/ac)
2002	Saunders	Magnify	2*	
2003	Lancaster	Regular/CellTech	-2	1
2003	Lancaster	Magnify	1	
2005	Saunders	Optimize/Soy XL	1	0
2009	Saunders	Standard	0	

*Significant difference at the 90% confidence level

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Summary of Nebraska On-Farm Research on Soybean Inoculation



Table 3. On-Farm Studies in Nebraska for Inoculation – Product minus untreated

Year	County	Product A/Product B	Yield Difference from Product A (bu/ac)	Yield Difference Product B (bu/ac)
2010	Saunders	Optimize	-1	
2010	Saunders	Optimize	-2	
2012	York	XiteBio	0	
2012	Hamilton	XiteBio	2.9	
2013	Hamilton	XiteBio	-1.3	

*Significant difference at the 90% confidence level

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Summary of Nebraska On-Farm Research on Soybean Inoculation



Table 4. On-Farm Studies in Nebraska for Inoculation – Product minus untreated

Year	County	Product A/Product B	Yield Difference from Product A (bu/ac)	Yield Difference Product B (bu/ac)
2013	Hamilton	Magnify LST	-1.9	
2013	Butler	Optimize 1x, 2x, 3x	0, -0.2, -0.2	
2018	Dawson	Seed/Seed+In-furrow		1

*Significant difference at the 90% confidence level

resultsfinder.unl.edu

Summary:

Average yield response across the 24 comparisons = -0.1 bu/acre



Iowa Soybean Association On-Farm Network on Soybean Inoculation



Table 2. On-Farm Studies in Iowa for Seed Treatment - Inoculation

Year(s)	Number of Trials	Product	Yield Difference (bu/ac)
2005-2006	11	TagTeam	-0.5
2012-2013	5	TagTeam LCO	0.4
2010-2011	2	Optimize	0.3
2007-2008	3	Launcher Pro	0.9
Summary	21	All	0.0

Summary: 90% confidence interval is -0.4 to 0.4 bu/acre

<https://www.iasoybeans.com/programs/isa-research/results/>

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