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Soybean Inoculation: Applying the Facts to Your Fields (Part two of a two-part series)

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This NebGuide details research conducted in Nebraska on soybean inoculants and provides a method and worksheet to determine if inoculation is needed in a specific field.

Why is it that we see soybean yield responses from inoculating with *Bradyrhizobia japonicum* in some cases but not others? In part one of this two-part series we discussed field conditions that support *B. japonicum* survival and encourage fixation of nitrogen. Please refer to the publication titled, *Soybean Inoculation: Understanding the Soil and Plant Mechanisms Involved*, NebGuide G1621 for more information on the basics of soybean inoculation.

This publication explains how to distinguish which fields will likely respond to inoculation with *B. japonicum* from those that will not. Fields are designated as either “new” or “old” based on how often soybean is grown. This designation is one criterion among many in deciding when to inoculate. In general, research trials across multiple locations in Nebraska have shown no yield advantage to re-inoculation.

What types of inoculant products are available?

B. japonicum are included on two types of carriers — peat and water. Peat (or humus) is used as a carrier in either a granular form, which is applied in-furrow, or in a powder form, which is applied to the seed at planting. Water-based products include liquid inoculants (seed applied or in-furrow) and frozen concentrates. New inoculants, introduced within the last 10

years, have increased potency due to sterile carriers and new packaging techniques. In addition, “growth promoters” now are being packaged with inoculants. These promoters can include an array of chemicals, with some of the newest products containing lipochitooligosaccharides (LCOs) or nutrient solutions. These products are suggested to increase early season growth, nitrogen fixation and overall plant health.

When do I need to inoculate soybean ground?

Deciding whether a soybean field should be inoculated depends on whether the field is “new” or “old”. A “new” soybean field is one that has never produced soybean. Nebraska fields that have never had soybean are decreasing as soybean production continues to spread westward. An “old” soybean field is one that has produced a soybean crop within the past four to five years. If the field has not been in soybean production for more than four to five years, it is again considered “new.”

“New” soybean ground

There is no question that new soybean fields should be inoculated with *B. japonicum*; research throughout the Midwest supports this. Unless soil nitrogen levels are very high (more than 60 lbs per acre), a yield increase (1 to 10 bushels per acre) should be expected when an inoculant is used. In south central Nebraska new soils showed a yield increase of up to 2 bushels per acre with inoculants in 2002 and 2003. When soybean fields are inoculated for the first time, a soil-applied inoculant (granular or liquid) is recommended because a higher

Table I. Soybean yields in Nebraska on “old” soybean ground (2001-2004). Yields are not significantly different between non-inoculated and inoculated soybean at any of the sites. Fungicides were applied with some of the inoculant products in these trials.

Year - Location	No Inoculant Applied	Inoculant Applied	Number of Inoculant Products in Trial
	-----bu/ac-----		
2001 – Waco, NE†	59.0	58.1	5
2003 – SCAL‡	68.5	66.0	12
2003 – Chapman, NE	81.6	83.0	6
2003 – Hebron, NE	50.1	47.0	6
2004 – Mead, NE	57.5	56.2	14
2004 – Hebron, NE	59.4	59.4	14

†This research was part of the Quad County On-farm Research Trials in south central Nebraska.

‡SCAL stands for South Central Agricultural Laboratory, located near Clay Center, NE.

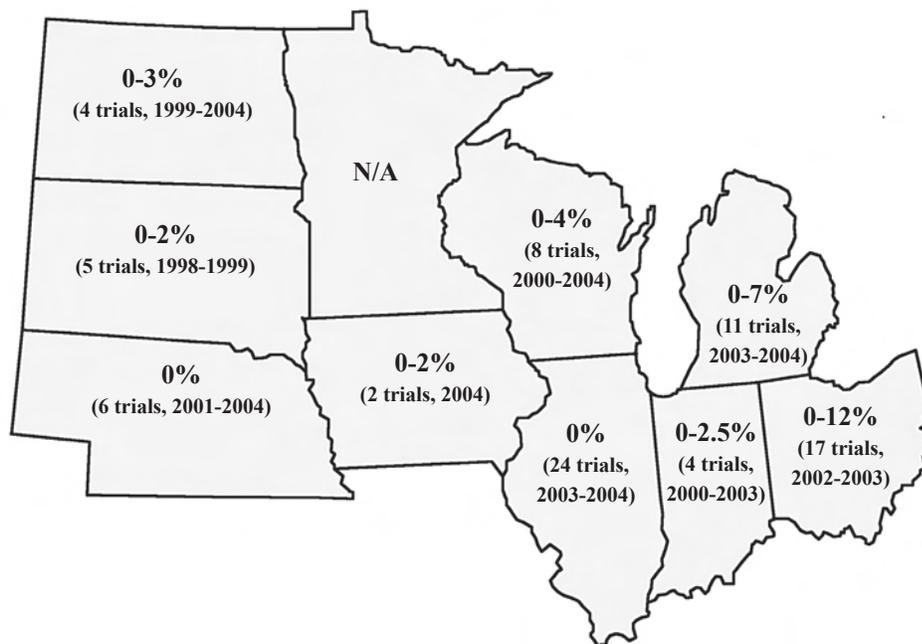


Figure 1. Soybean inoculation yield response on “old” fields, multi-state university research trials. Values per state represent yield response as a percentage of total yield. Data was averaged across all inoculant products in individual research trials. Therefore, specific yield advantages with some products may be masked by lower-yielding products.

B. japonicum population can be applied. Research has also shown that when an inoculant is applied to the seed, both dry and liquid inoculants perform similarly.

“Old” soybean ground

Will Nebraska producers see a yield increase from re-inoculating a field that has recently had soybean? Fields that have had an inoculated soybean crop before are able to retain the bacteria from year to year. These bacteria are able to inoculate the next soybean crop. New inoculant products contain strains of *B. japonicum* that are said to be more aggressive than those in previous products. These new inoculant products are said to fix more nitrogen and increase yield compared to soybean inoculated by *B. japonicum* carried over from previous inoculations. University of Nebraska–Lincoln research conducted from 2001 to 2004 did not show a yield difference between any inoculation product and an untreated control when applied to soybean on “old” ground. Results from this research across south central Nebraska are highlighted in *Table I*. Nodule counts on roots were also unaffected by inoculant treatment on “old” ground (data not shown).

Some states in the Midwest have shown yield increases on “old” ground from inoculants (*Figure 1*). A good soil environment is critical to the development of nodules and the overall productivity of *B. japonicum*. A soil environment that is not supportive of long-term bacteria survival could be the reason we see some positive yield responses when fields are re-inoculated in certain regions. Factors that could increase mortality of soil bacteria include the soil pH, temperature, texture, water content and presence of fungicide. A yield response to re-inoculation appears to occur more often in the northern and eastern soybean production states within

the Midwest. Northern states may see a response due to cold spring temperatures which limit growth and multiplication of *B. japonicum*. Seed-applied fungicides also are used more extensively in eastern production states and this could be responsible for part of the observed yield response. The Great Plains region does not have a consistent yield response to re-inoculation of “old” fields.

Overall recommendation

Inoculation of a field is recommended if soybean has not been grown within the past four to five years. If the field has had soybean more recently, use the *Soybean Inoculation Decision Worksheet* to decide if re-inoculation is necessary. In “old” fields, a yield increase from re-inoculation will likely be found in situations where there are *multiple* factors deterring bacteria survival and not due to *one lone* factor.

Reference

Percent yield response data for *Figure 1* was supplied by the following university extension specialists: Robert Henson, North Dakota State University; Robert Hall, South Dakota State University; Palle Pedersen, Iowa State University; Roger Borges, University of Wisconsin–Madison; Emerson Nafziger, University of Illinois; Kurt Thelen, Michigan State University; Shawn Conley, Purdue University; and Jim Beuerlein, The Ohio State University.

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NOTE: Use your Adobe Reader® to fill in the checks in the following form and print out the results. Check each field that applies. The form will automatically add the results as you check the field. The file cannot be saved to your computer, but can be completed and printed to create a record.

From University of Nebraska–Lincoln Extension NebGuide, G1622 Soybean Inoculation: Applying the Facts to Your Fields, page 3.

Soybean Inoculation Decision Worksheet for “Old” Fields

“Old” fields are those that have produced soybean within the past four to five years.

Use this checklist as an evaluative tool in making decisions relevant to a specific field. Simply read each question and decide how your field fits that situation. Points for each answer are within each box in parentheses. After finishing all the questions, total these points up for each column and add the two columns together to have a total point value for your field.

Answer these questions for your specific field:

- 1) Is it in a consistent corn–soybean rotation?
- 2) Will the field be planted early (before May 1)?.....
- 3) Do parts of this field experience long periods of flooding (more than four days)?
- 4) Is the pH of the field below 5.0 or above 8.0?
- 5) Does the field contain a high percentage of sand?.....
- 6) Did the last crop of soybean appear yellow, especially during the second half of the season?.....
- 7) Have seed-applied fungicides been used with each previous soybean crop?.....
- 8) Do the crops often experience severe water stress?.....
- 9) Is the field in a no-till system?

Yes	No
_____ (0)	_____ (2)
_____ (1)	_____ (0)
_____ (3)	_____ (0)
_____ (3)	_____ (0)
_____ (3)	_____ (0)
_____ (4)	_____ (0)
_____ (2)	_____ (0)
_____ (3)	_____ (0)
_____ (3)	_____ (0)
Total your points for each column:	
Yes = _____ No = _____	
Add “Yes” and “No” = _____	
<i>(Use this value in the Decision Chart at left)</i>	

Decision Chart (based on your combined value from the table)

Total Points	Outcome
0-6	Will likely <i>not</i> have a yield response from re-inoculation.
7-12	Possible yield response from re-inoculation.
13+	Will likely have a yield response from re-inoculation.

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