

Inoculant Use on Soybean Seed

The use of inoculants on soybean seed prior to planting is commonplace in some areas of the Soybean Belt. A 2007 survey (3) of farmers by crop specialists at land-grant universities found that 18 percent of farmers in Indiana used an inoculant while a separate survey in 2008 found that inoculants were used by 85 percent of farmers in Wisconsin (7). Inoculating soybeans with products containing the bacterium *Bradyrhizobium japonicum* is considered an inexpensive management practice to increase yield. However, results from university research conducted across Iowa and other Midwest states suggest the yield gain from inoculants on soybean is inconsistent.

WHAT ARE RHIZOBIA?

Rhizobia are bacteria capable of symbiotically fixing nitrogen (N) in association with a host plant, most typically a legume. *Bradyrhizobium japonicum* is the bacterium that fixes nitrogen with soybean. The bacterium forms a symbiotic or beneficial relationship with roots allowing for biological nitrogen fixation to occur. The success of growing soybean depends greatly on the existence of symbionts such as rhizobia in the soil. Nitrogen fixation is the conversion of atmospheric N_2 to ammonia (NH_3) and then to N-containing organic compounds that become available to the host plant. Rhizobia infect root hairs and ultimately form root nodules that are sites of N fixation. Biological N fixation accounts for 25 to 75 percent of the annual N uptake for the soybean crop (13) and is



Image: Albert Tenuta, OMAFRA

Rhizobia infect root hairs and ultimately form root nodules that are sites of N fixation. Healthy soybean roots should have eight to 20 large nodules at R1 and may have several hundred on a mature root.

absolutely essential to producing high yielding soybeans.

WHEN SHOULD INOCULANTS BE USED?

Inoculants are recommended for use on soybean in the Midwest if soybean has not been grown in a field in the last five years or if a field has been flooded for more than seven days. Research shows that the population of rhizobia remains sufficient once it is introduced into the soil and a leguminous crop such as soybean is grown, unless a severe environmental stress occurs such as long-term flooding.

There is some evidence however, that inoculation may also be warranted after periods of drought. Peña-Cabriales and Alexander (10) reported a rapid decline in rhizobia as soil dried, followed by a slower decline once the soil had reached water deficit conditions similar to those expected during drought conditions. The addition of water to the soil did not result in growth of the rhizobia population; the population continued to slowly decline. When the same soil was returned to severe water deficit conditions, the rhizobia population continued its rapid decline. This suggests rhizobia populations will decline during drought periods even if brief periods of rain occur during the growing season. Populations of rhizobia will likely increase once the soil is returned to water holding capacity for extended periods, especially if healthy soybean nodules are present (11).

DO INOCULANTS INCREASE YIELD?

Beuerlein (2) evaluated the performance of inoculants over 10 years and 64 field trials in Ohio and reported inoculated soybeans yielded two to seven bushels per acre more than non-inoculated. Schulz



Image: United Soybean Board

and Thelen (12) tested eight commercial inoculants at nine locations in Michigan in 2009 and 2010. Across locations and years, they reported a soybean yield advantage of 1.3 bushels per acre from inoculated plots. However, inoculants increased yield in only six of fourteen environments (environment = year x location) on fields with a previous soybean cropping history, suggesting the response of

soybean to inoculants is field and environment specific.

Research shows that inoculants do not always increase yield of soybean. Several researchers have reported that the effectiveness of inoculants was reduced when soil conditions after planting were very dry or too wet, or when soil pH is below 6.0 (1,5,9,12).

De Bruin and coworkers (4) combined the results of independent research trials that tested 51 inoculant products in 73 environments in Indiana, Iowa, Minnesota, Nebraska, and Wisconsin between 2000 and 2008. They reported 63 of the 73 environments showed no significant yield response of soybean to a seed-applied inoculant. Four of the environments showed a negative response between the range of five and seven percent. Only six of the environments showed a positive response, with a range of five to twenty-three percent greater yield than the control.

Similarly, Furseth and coworkers (6,8) reported that soybean yield was not affected by seed-applied inoculants in a study conducted across 18 environments in Wisconsin. They reported a positive yield response to inoculants from only three of the 18 environments. They also reported the largest yield increases were recorded in environments that had nearly zero soil rhizobia prior to planting. Previously, Schulz and Thelen (12) had also reported a yield advantage of inoculated plots at locations that had nearly zero soil rhizobia.

CONCLUSIONS

Soybean inoculants can increase yield. However, this positive yield response is inconsistent in fields where soybean has recently been grown. Surveys suggest inoculants are widely used in

some Midwest states despite inconsistent results. Farmers may be using inoculants as a management practice to improve yield because of their low cost and because there appears to be no ill-effect from their continued use.

Inoculants are recommended for use on soybean in the Midwest if soybean has not been grown in a field in the last five years or, if a severe environmental stress has occurred such as long-term flooding or drought. Research shows that the population of rhizobia remains sufficient once it is introduced into the soil and a leguminous crop such as soybean is grown.

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Prepared by David Wright and Andrew Lenssen,
Department of Agronomy, Iowa State University.

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Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Cathann A. Kress, director, Cooperative Extension and Outreach, Iowa State University of Science and Technology, Ames, Iowa.