

Inoculants – Do We Need Them if Soybean Follows Soybean?

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Soybean Inoculation and Nitrogen Fixation

Key Takeaways

- > Soybeans have the greatest nitrogen (N) requirement per bushel among row crops
- > Biological N-fixation generally provides 40-70% of total soybean N requirement
- > Inoculum (*Bradyrhizobium japonicum*) may be necessary in fields not recently planted with soybean
- > Well-nodulated roots with active nodules are foundational for soybean growth and yield potential

Why Nitrogen Matters

Although the atmosphere has 78% N₂ gas, plants cannot use it directly. Instead, they must get N from the soil. Soybean is a legume that forms a symbiotic relationship with a specific bacteria called *Bradyrhizobium japonicum* to transform the atmospheric N₂ into plant-available N in the soil. These bacteria need to be introduced through inoculation because they are not naturally occurring in US soils.

N-fixing bacteria colonize root hairs to form nodules. If nodulation and N-fixation fail, a 50-bu soybean crop would require 100-175 lbs N per acre in addition to the supply of N in the soil.

Fun Facts

40-70% | N-fixation generally provides 40-70% of total N for soybeans¹

3-4x | Soybean crops require three to four times more N per bushel than cereal crops such as corn, wheat, or rice.

Cafaro, N., Casteel, S., Francisco, E., Holshouser, D., Kandel, H., Moseley, D. (2024). United Soybean Board (Plus, contributions from the Science for Success group)



Nodulation on a soybean root

Need to Know



N-fixing bacteria can be introduced through seed or in-furrow inoculation in the form of powders, liquids, or granular.



Bacteria are alive and should not be exposed to high temperatures or direct sunlight.



Even when soybean seeds are inoculated with the right bacteria and method of application, satisfactory nodulation is not guaranteed.

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U.S. farmers are beneficiaries of the practical research results that come from work funded by the soybean checkoff – national, regional and state. Now, Science for Success is adding another element to the effort. The checkoff-funded program is amplifying access to timely, data-driven best management practices (BMPs) so farmers can better manage agronomic sustainability.

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National group of soybean agronomist collaborating to deliver research-based information for soybean production

Soybean Nitrogen Fixation

- Inoculate with *Bradyrhizobium japonicum* bacteria
 - Soybean takes up approximately 3.75 – 4 pounds of N/bu of grain
 - convert atmospheric nitrogen gas (N_2) into ammonium (NH_4^+).
 - Can fix up to approximately 75% of the required nitrogen
 - Without proper nodulation and fixation, a 50-bushel crop would need 100-175 lbs N per acre plus the nitrogen in the soil.
- Nodules can be evaluated beginning at V3 growth stage (approximately 7 active nodules)



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Poor Soybean Nodulation

- Possible Causes
 - Low soil pH: Low availability of molybdenum
 - Do not combine *Bradyrhizobium* and molybdenum as a seed treatment unless it is directly before planting
 - Droughty, saturated soils, or coarse textured soils
 - Compaction
 - Less root hair sites for rhizobia infection and nodulation
 - Extreme temperatures
 - High salinity
 - Nutrient deficiency
 - High soil N level
 - Treating seed and storing for too long



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Soybean Nitrogen Fixation

- Legume plant - fix nitrogen (generally no additional nitrogen is required)



2022 Dean Lee Research Station Data

Treatment	A1EA	A2EB
	Yield (bu/A)	
<i>Bradyrhizobium</i>	68.4	63.4
Non-treated Control	66.7	61.0

Dr. Syam Dodla Inoculant Research Results (2016)

(Red River Research Station)

Treatment	Avg Yield (bu/a)	% control
Experimental #3	45	107
Commercial Inoculant # 2	44	105
Commercial Inoculant # 1	44	105
Commercial Inoculant#3	44	105
Riznate	44	104
Experimental #1	43	103
Experimental #2	43	103
Control	42	100

- Soybean after corn
- All *Bradyrhizobium* trts
- Four reps per trt
- Not sure if the trial had significant differences

Final Thoughts

- Consider other limiting factors
 - Other nutrients than nitrogen
 - (Example: *Bradyrhizobium* surviving from previous years and soil residue N may be enough to be less limiting than a potassium deficiency)
- Most common recommendations are to inoculate soybean seed if the field has not been planted to soybean for 3-5 years.
- Research has indicated it is possible to gain a slight to moderate yield advantage when inoculating in a regular soybean rotation.
- Hypothesis: Similar results would be seen in a soybean monocrop if other limiting factors were not present such as an increase in disease pressure.

Questions

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