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Inoculation of Soybeans Maximizes Yield:
Factors Impacting N Fixation

Soybeans and Nitrogen

- Soybeans need a significant amount of nitrogen to support growth and yield – requiring approximately 5lbs available nitrogen (N) for every bushel of yield.
- Nitrogen is acquired by the soybean plant from N fertilizer, mineralized soil N, and/or nitrogen fixing rhizobium (rhizobia can provide approximately 60 percent of the plants N needs).
- As with other legumes, soybeans have naturally evolved to fix atmospheric nitrogen by forming a symbiotic partnership with specific rhizobial bacteria which then form root nodules.
- The root nodules are highly specialized sites where nitrogen gas is converted into ammonium (NH_4^+), an important protein building block for the plant.
- Not all nodules fix nitrogen as efficiently as one another (even nodules on the same plant!). Nodules formed by a high-quality inoculant source using selected/adapted strains have higher levels of nitrogen contribution than those formed by natural rhizobium found either in the soil or from poorly adapted strains in commercial inoculants.
- Inoculant manufacturers have selected elite rhizobium strains based on internal criteria and provide formulations of varying claims, quality and performance for application to the seed and/or in-furrow.

Benefits of Inoculation With an Effective, High-Quality Strain Adapted Inoculant

- Certain soil conditions will significantly reduce levels of indigenous rhizobia, increasing the reliance on a high-quality inoculant. These conditions include:
  - Flooded/saturated soils: as oxygen levels decrease in the soil as a result of water saturation, rhizobia quickly reduce in vitality and survival.
  - Hot, dry soils: rhizobial cells are very sensitive to stress, and populations will quickly decline, especially in the upper soil planting zone.
  - Soil pH: soil pH below 6.0 or above 8.5 create challenging environments for the plant and rhizobia – changing nutrient availability that otherwise are needed for effective nodulation and N fixation.
  - Natural evolution of indigenous rhizobial results in increased populations with survival and competitiveness in the soil, but typically reduced N fixation efficiency.
  - Light (low organic matter) soils have reduced indigenous rhizobia and soil N.
  - High Salt (EC) content can impact rhizobia survival.
  - Other plant stressors include herbicide injury, soil compaction, cold early growing conditions, SCN, and bacterial feeders (nematodes) can impact nodulation and the N fixation process.

- Depending on the product and how the product has been stored, rhizobial inoculants will remain viable in pack, with certain products offering robust extended on-seed survival/pesticide compatibility – importantly maximizing numbers of viable rhizobia being applied at planting/seeding.
- Commercial inoculants will quickly occupy the finite number of nodulation sites on the soybean root system (inoculant occupation of crown nodules is preferred for optimal performance), limiting nodulation by the less effective (though sometimes very competitive) indigenous rhizobia.
- Strong return on investment (and quantitative yield potential).
- Inoculants can be formulated with additional technologies to promote plant growth and health.

Inoculants

Product	Key Disease/ Technology	Standard Use Rate	Key Benefits
Vault® IP Plus Seed Treatment *Liquid*	Rhizobial inoculant/ Biofungicide ▪ Rhizoctonia ▪ Fusarium	▪ 1.1 fl. oz/cwt or 0.51 fl. oz/140,000 seeds	▪ Best-in-class nitrogen fixation with proven, superior rhizobial strain ▪ EPA registered, dual-strain biofungicide promotes more vigorous roots and increased nutrient uptake ▪ Lowest application volume inoculant/biofungicide treatment available in the market ▪ Fewer components for less waste, more time saving and more treated units per case
Vault NP for Soybeans Inoculant *Liquid*	▪ Liquid soybean inoculant for seed treatment or in-furrow application	▪ 4.2 fl. oz/cwt (on seed) or 1.96 fl. oz/140,000 seeds	▪ Highly effective rhizobia strain and OMRI listed ▪ Apply directly to seed or in-furrow ▪ Convenient commercial application or on-farm use
Vault SP for Soybeans Inoculant *Peat-based*	▪ Rhizobial soybean inoculant for on-farm, planter box treatment	▪ 2.8 oz/cwt	▪ Sterile, peat-based carrier for durable and high rhizobia potency ▪ Easily applied in planter box with excellent adhesion to seed
Rhizo-Flo® for Soybeans Inoculant *Granular*	▪ Granular peat soybean inoculant for in-furrow or double inoculation uses	▪ 6.5 lbs/acre (drilled seeding)	▪ Granular formulation helps protect rhizobia from high surface soil temperatures and dry soil conditions ▪ Contains highly effective rhizobial strain ▪ Supplies large number of viable and effective rhizobia directly to the root zone

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