Successful Inoculant Selection

WHAT YOU'LL LEARN

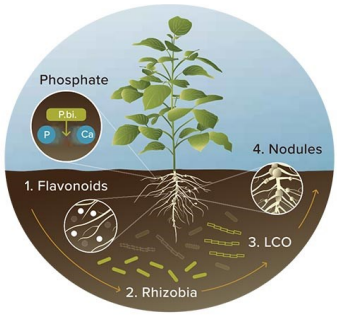
- Inoculants can help legumes achieve successful nodulation.
- There are several factors regarding product performance that are strongly influenced by the count of rhizobia on the seed.
- Nodulation studies in large seeded legumes seem to indicate that counts somewhere between 50,000-100,000 CFU/seed are a common target at the time of planting to reliably achieve product performance.

WHY IT MATTERS

Legumes are unique in that they have the ability, with the help of rhizobia, to transform nitrogen (N) gas from the atmosphere into a form of nitrogen that plants can use.[1] Nearly 15% of the plant's net photosynthetic energy goes into N fixation. Different legume species have different strains of rhizobia that maximize this fixation.

The plant tightly controls when it will allow rhizobia to colonize it and will first use up as much soil available N as it can because it is readily available and has no energy cost to the plant. When the soil N has been removed, legumes produce very specific compounds called flavonoids, that are secreted from its roots into the soil signaling for rhizobia.

The signals sent by both the legume and rhizobia are very specific. If different signals are produced other than these, the N fixation process doesn't occur. Commercially applied inoculants can enhance the nodulation process and make the crucial pieces available even in cases of environmental stress when signaling cannot be produced naturally.



P.bi = *Penicillium bilaiae*
P = *Phosphate* Ca = *Calcium*

Figure 1. TagTeam® LCO XC and Acceleron® B-200 SAT Inoculant process.

Figure 1 shows this process and how TagTeam® LCO Inoculant contributes to nodulation.

WHAT TO LOOK FOR IN AN INOCULANT

Not all inoculants are created equal and reading the product label is a crucial first step in understanding the product. If a product contains an EPA-registered ingredient, the label is the law. Deviating from the label rate is usually not recommended and may not be economical or provide the desired product results.

There are several factors regarding product performance that are strongly influenced by the count of rhizobia on the seed. Three main ways to influence these counts are application rate of the inoculant, concentration of the inoculant applied, and preservation of the applied rhizobia.

The planting window is defined as the time between the application of the product and planting and the subsequent time needed for the product to start working. Seed load directly influences a number of factors that contribute to the planting window. These factors include:

- Desiccation
- Chemical resistance
- Environmental factors
- Equipment
- Manufacturing
- Packaging

The rapid drying down, or desiccation, of an inoculant on seed in most commercial settings contributes to a high loss of rhizobia. The larger the load of rhizobia on the seed, the higher the probability that enough will survive desiccation. This can be influenced by the total seed load of seed treatments and their composition, the relative dryness of the seed, the seed coat, and the environmental conditions at the time of application.

Seed treatment compatibility has a huge impact on planting window. Always consult your inoculant compatibility recommendations before applying to make sure that your treatment, type of application, and required planting window meet your needs.

Drying times are affected by the ambient air temperature and

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humidity. Warm, dry conditions during treatment and temperature and humidity changes during storage can be very harmful to the on-seed survival.

Equipment type and operating procedures can have an impact on the preservation of rhizobia. Balancing the need for dry seed and not damaging the rhizobia by drying too fast is an art. Rather than adding fans, heaters, ladders, or other drying aids, it is best to slow and level the barrels on continuous treaters. Additionally, bypassing the atomizer on the treater and reducing dwell times in batch treaters can help preserve rhizobia.

Manufacturing can have significant effects on securing higher rates of desiccation resistance to a product. Certain sugars, like trehelose, have the ability to help the bacteria resist desiccation. These sugars are called osmoprotectants. The fermentation and other processes should be optimized to ensure that high concentrations of these substances are present.

The most indirect factor of those discussed for on-seed survival is packaging. Bacteria like rhizobia are living organisms that require oxygen and most liquid inoculants today are packaged in plastic films that allow for the transfer of gases like oxygen and carbon dioxide. If the product is packaged in a non-gas permeable plastic container, enough air needs to also be included in the package to support the rate of metabolism. Knowing the amount of air needed can be difficult to estimate because of variable environmental and metabolic rates, making this packing type more challenging.

Most liquids are also packaged in clean rooms into sterile packaging. This is because contaminants compete with the target bacteria for resources like air and food and can render the product unusable. Contaminants can also overrun the bacteria and change the pH of the broth or produce metabolites that are harmful to the bacteria. Package convenience may come at the expense of product quality. Aseptic packaging and those with breathable films can offer increased viability and potentially higher product quality.

APPLICATION CONSIDERATIONS

Following best management practices and applying a quality, high count product are the first steps to a successful application. The problem with a higher application rate to achieve the target on-seed load is that in today's seed treatment market, total application rates for polymers, pesticides, flowability agents, inoculants, and seed-applied nutritional products are close to exceeding the total liquid holding capacity for a unit of seed. Holding capacity is a function of the properties of the seed coat, seed size (surface area), and properties of the seed treatments including viscosity, suspended solids, drying time, etc. Consequently, there is a pressing need to concentrate inoculants to preserve space on the seed for everything else.

Although holding capacity can be a concern, there doesn't seem to be any limiting factors, like reduced germination, from "over" applying too much inoculant. However, nodulation studies and field performance research in large seeded legumes seem to indicate that counts somewhere between 50,000-100,000 CFU/seed are a common target at the time of planting to reliably achieve product performance.

FINAL CONSIDERATIONS

The plant ultimately controls nodulation and no matter how much inoculant you apply, the plant will only allow for as much nodulation development as it needs to meet its N requirement. Strain(s) selection and fermentation process heavily influence the durability of the rhizobia and are very important to nodulation success. Strain selection in particular determines the infectivity and effectiveness of the rhizobia, the two most critical criteria in an inoculant product. TagTeam® LCO XC and Acceleron® B-200 SAT applied on-seed as part of the seed treatment package are an important step in mitigating against potential stresses that may impede or inhibit nodulation.

In a cropping system, N fixation by legumes can be in the several hundred pounds per acre range.[2] A quality inoculant can help achieve nodulation potential and capture the benefits of N fixation.

Sources:
[1]Evers, G.W. Need for Legumes. Texas A&M AgriLife Research & Extension Center at Overton. http://overton.tamu.edu/faculty-staff/gerald-wayne-evers/cool-season-legumes/need-for-legumes/#.WVZwg4MrKpp
[2]Flynn R., Idowu J. 2015. Nitrogen fixation by Legumes. Guide A-129. http://aces.nmsu.edu/pubs/_a/A129/