

Advanced BioNutrition Corporation's Dry Powder Formulation Approach to Stabilize Biologicals (e.g., *Bradyrhizobium japonicum*) on Seed

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Abstract

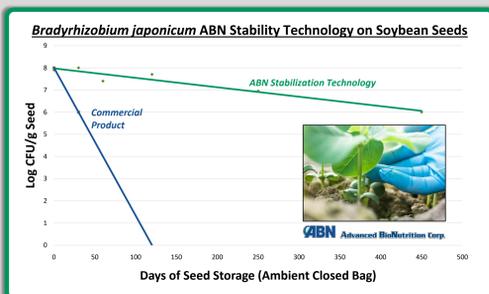
The use of biologicals represents an important and evolving tool for enhancing crop productivity and crop protection. Advanced BioNutrition has developed a novel, proprietary dry powder formulation approach that stabilizes biologicals such as rhizobia on the shelf and delivers long-term stability on seed.

Scientific/Technical Focus

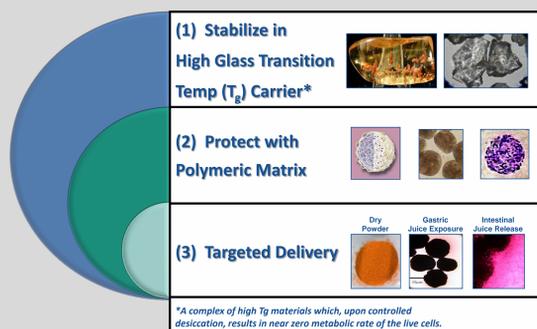
Using ABN proprietary technology, improve the stability, application and delivery of microbes (e.g. *Bradyrhizobium japonicum*) on seed or in furrow for plant health. The goal is to extend the shelf life of formulated products and on-seed stability beyond current commercial standards (e.g., greater than 120 days on seed and 2 years on shelf).

Key Results and Accomplishments

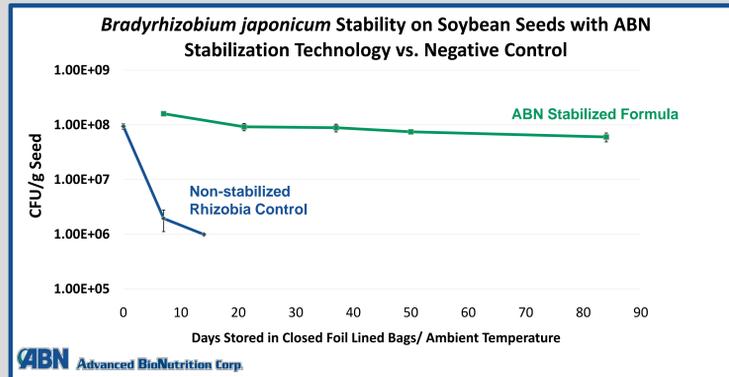
ABN has scouted, developed and delivered stabilized microbial dry powder formulations using ABN proprietary technology both on-shelf and on-seed with several strains of *Bradyrhizobium*.



Principal Attributes of ABN Technologies



Results

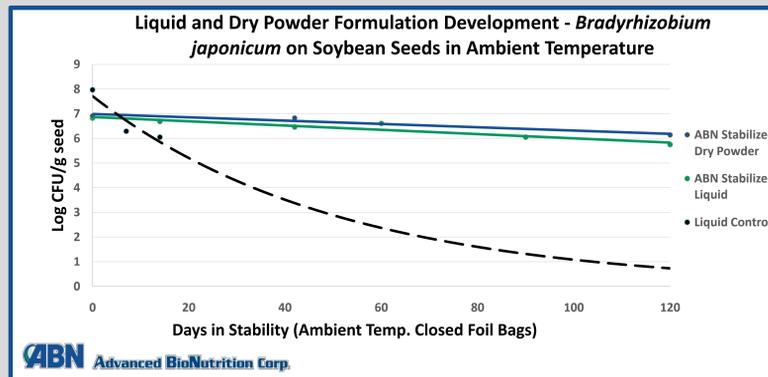
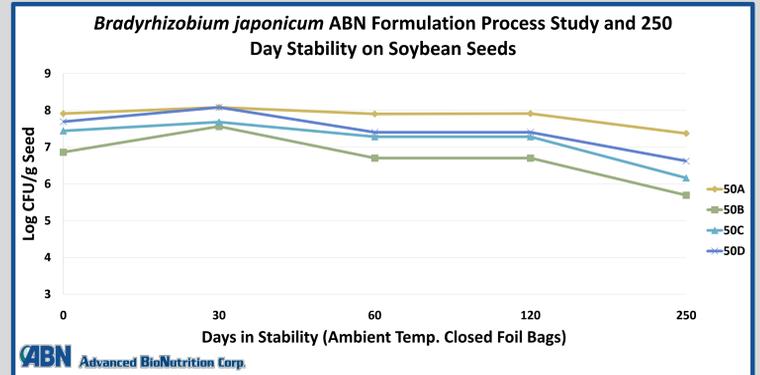


With ABN's Dry Powder Stability Technology, microbes such as *Bradyrhizobium japonicum* see less than 1 log (CFU/g seed) viability difference 90 days after application on soybean seeds.

Without this stabilization technology, the control loses over 2 log CFU/g seed after only 14 days.

ABN dry powder formulations can provide over 9 months of on-seed stability.

This graph demonstrates 4 sets of ABN stabilized *Bradyrhizobium* with over 9 months of on-seed stability averaging less than 1.0 log loss



ABN is currently developing liquid formulation technology that demonstrates approximately 100 days of on-seed stability with less than 1.0 log loss in an ambient temperature closed foil bag environment.

ABN has experience with a broad range of microorganisms	
Microbe	Stability Application
Lactobacillus sp.	Significantly longer-term stability versus commercial products
Bifidobacterium sp.	Stabilization in a variety of food applications
Lactobacillus sp.	Stability in low pH environments
Bacteriophages	Stabilization for use in food safety
Rhizobia sp.	Greater on-seed stability
Fungi	Improved stability (shelf life and on-seed) versus unformulated

Application components, process changes, and chemistry can have a big impact on microbial stability			
Sample Set	Variable	Log Loss 120 Days	Log Loss 180 Days
75A	Application component	0.66	0.70
75B	Component/process	0.56	0.92
75C	Application component	0.67	0.52
75D	Component/process	0.77	1.10
75E	Process	1.0	1.01
75F	Process	1.0	1.29
75G	Chemistry	2.05	2.26

Changes in key formulation compositions can vastly improve microbial survival		
Sample Set	Change	Log Loss /g Seed After 120 Days
73A	Formulation composition 1	2.39
73B	Formulation composition 2	2.82
73C	Formulation composition 3	3.44
73D	Formulation composition 4	1.62
73E	Formulation composition 5	1.24
73F	Formulation composition 6	0.87

ABN Strategic Objectives for Ag Biologicals:

- ✓ Stabilize biologicals (e.g., microbes) on-shelf, on-seed and in furrow to improve plant health and increase yield.
- ✓ Expand the use of microbes in agriculture.
- ✓ Attract customers and partners that have a need for improved microbial stability.
- ✓ Meet customer needs by developing stability equivalent to or better than commercial standards (on-shelf and on-seed) including in high humidity environments.
- ✓ Partner with customers to develop, scale-up and commercialize stable ABN formulations containing one or more microbes.

ABN Opportunities as a "Solution Provider":

ABN is a "Solution Provider" for companies looking to commercialize stable microbial applications in agriculture for plant health, leading to licensing or development agreement opportunities.



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