What is *Bacillus amyloliquefaciens*?

*Bacillus amyloliquefaciens* (BAA) is a bacterium active in the soil root zone (rhizosphere), and is commonly found in soil ecosystems worldwide, as well as on fresh produce and dried foods.  

BAA growth begins underneath the outermost cells (or “skin”) of primary plant roots at the points where lateral roots grow and then spreads along the root surface.  

BAA feeds on the numerous organic compounds (such as sugars, vitamins, and amino acids) that plants exude into the rhizosphere. Simultaneously, BAA produces plant growth-promoting compounds that are taken up by plant roots (figure 1). Various BAA-formulated products are permitted for a wide range of foliar and soil-applied disease management uses on agricultural crops (e.g., grape, lettuce, potato, soybean, strawberry, cucurbits, fruiting vegetables, and pome fruits), ornamental plants, turfgrass, and in plant nurseries, greenhouses, and shade houses.  

BAA inoculants are sold in two formulations: a wettable powder that can be applied using ground application equipment, aerial spraying, or irrigation, and a talc-based powder that can be applied using a dry planter box.

What is the difference between native and commercial BAA types?

Native BAA strains are present in soils worldwide. Commercial products contain strains of BAA known to colonize plant roots quickly and aggressively, and in controlled studies, promote plant health, plant disease control, or both. Several BAA strains are used in commercial inoculants, including *Bacillus amyloliquefaciens* D747, *Bacillus amyloliquefaciens* TJ-1000, and *Bacillus amyloliquefaciens* FZB42. Many of their impacts on crops are similar, but there are strain-specific interactions. Therefore, individual BAA inoculants may perform differently under similar field and weather conditions.

How can BAA help my crops?

The following summarized research shows that applying commercial BAA inoculant strains can potentially increase plant growth and disease resistance to provide both biocontrol and biofertilization.

**Plant disease management**

BAA controls other soil pathogens by competing with them for nutrients such as iron and by producing antibiotics or bacterial-destructive (lytic) enzymes.

---

**Key facts**

- BAA is a spore-forming soil bacterium that grows well near plant roots.
- BAA inoculants have the potential to stimulate plant growth.
- BAA inoculants have the potential to suppress plant-pathogenic bacteria and fungi, and can minimize disease damage from several root rot-causing fungi and fungal-like microbes including *Botrytis, Fusarium, Pythium*, and *Rhizoctonia*.
- BAA must be used preventively, as it will not cure diseased plants.
- No soil test is available to determine if BAA application is recommended; there is little data available to assess if BAA inoculants will be economically beneficial.
• BAA has not successfully controlled black scurf, silver scurf, or common scab of potato when applied at the time of planting in Wisconsin.

• BAA can outcompete other soil bacteria because its genetic makeup is more resistant to plant defense mechanisms.

• BAA promotes general plant disease defenses and increases the “immunity” (acquired resistance) of inoculated plants.

• In soybean, BAA has increased plant systemic resistance against bacterial pustule pathogen.

• In lettuce, BAA has reduced the severity of bottom rot disease.

**Increased crop yield**

BAA colonization of crop roots can lead to increased yields.

• At 75% of recommended fertilizer rates, greenhouse-grown tomato plants inoculated with BAA showed growth, yield, and nutrient (N and P) uptake equal to non-inoculated plants that received the full fertilizer rate.

• BAA increased the growth of inoculated corn plants and stimulated corn growth under phosphate-limited conditions compared to non-inoculated plants.

• BAA-inoculated soybean seeds showed increased nutrient content in plant residue (K, P, Zn, Fe, Cu, and Mn) and seeds (K, P, Fe, and Mn) over non-inoculated seeds.

• In years conducive to infection by *Fusarium verticillioides* and fumonisin production, seed-applied BAA may improve quality of corn grains by reducing toxin content.

• BAA applied to potatoes at the time of planting in Wisconsin did not significantly increase yield compared to non-treated controls in multiple years of study.

**Nematode control**

• In tomato production, BAA reduced the number of nematode eggs in roots, juvenile worms in soil, and plant galls on tomato.

• Industry patent filings indicate that BAA inoculants may be useful in controlling a range of root-knot, cyst, lesion, and ring plant parasitic nematodes.

**Pesticide use**

Herbicides, nematicides, and most fungicides do not normally affect BAA activity. Antibiotics would potentially impact BAA, but in crop production antibiotics are only commonly applied to apple and pear orchard foliage to control fire blight. Copper-based fungicides are also antibacterial but are foliar applied only. Foliar-applied compounds are highly unlikely to affect soil inoculants.

**Will my crop management practices impact BAA growth?**

In contrast to other soil microorganisms like arbuscular mycorrhizal fungi (AMF) which remain viable year-to-year, BAA are host dependent and must regrow annually. Thus, crop management practices in any single year will have little impact on BAA.

• BAA colonize plant roots and grow best under conditions that are also favorable to plant growth (moderate temperatures and adequate soil moisture).
• While conservation tillage and legume-based crop rotations generally improve microbial diversity over conventional tillage and monoculture, their specific effects on BAA have not been studied.18
• BAA are not crop specific and will colonize all crops regardless of rotation.

Can I use BAA and other inoculants at the same time?
BAA inoculants and other inoculants can generally be used together. BAA, *Trichoderma* and AMF naturally coexist in the rhizosphere. Monsanto’s QuickRoots® product, for example, contains both BAA and *Trichoderma virens*.

Should I inoculate my seeds/soil with BAA? Research has indicated that BAA can potentially benefit plant health in crops such as corn, soybean, ornamentals, and vegetables. Commercial use of BAA inoculants in field and vegetable crops is limited but growing. Benefits to potatoes have been documented elsewhere,19 but research in Wisconsin has not yet shown improvement. Limited adoption of BAA in field crops may be the result of multiple factors including cost, relative efficacy compared to conventional pesticides and fertilizers, and lack of research on specific crops. In addition, field studies on non-traditional products such as BAA are not often published, especially if there was no increase in yield, leading to a bias in published literature toward studies with positive results.

It is important to remember that BAA should be used preventively as it will not cure diseased plants.

BAA has a shorter shelf life than most conventional pesticides and must be stored under conditions recommended on the label to remain effective.

Inoculants will need to be reapplied each season, as they do not cause long-term changes in the soil microbial community composition. Plant impacts result from direct interaction with inoculant strains.20

References
1 United States Environmental Protection Agency. "Biopesticides.” [website link]
2 Lugtenberg, B., and F. Kamilova. "The species responsible for the plant colonization and resulting benefits are not always the same. The *Bacillus* genus contains many different species that have been proven effective."
3 Caldeira, A. T., et al. "The *Bacillus* genus contains many different species that have been proven effective."

Further reading
Iowa State University Agronomy Extension (NCR-103). "Compendium of Research Reports on Use of Non-Traditional Materials for Crop Production." [website link]

University of Georgia Cooperative Extension. "Soil Inoculants.” [website link]
THE VALUE OF BACILLUS AMYLOLIQUEFACIENS FOR CROP PRODUCTION


6. See note 2 above.


14. See note 7 above.


20. See notes 1 and 8 above.

© 2016 University of Wisconsin System Board of Regents and University of Wisconsin-Extension, Cooperative Extension. All rights reserved.

Authors: Department of Soil Science: Geoffrey Siemering, outreach specialist; Matthew Ruark, associate professor. Department of Plant Pathology: Amanda Gevens, associate professor. All with UW–Madison and UW-Extension. Cooperative Extension publications are subject to peer review.

University of Wisconsin-Extension, Cooperative Extension, in cooperation with the U.S. Department of Agriculture and Wisconsin counties, publishes this information to further the purpose of the May 8 and June 30, 1914, Acts of Congress. An EEO/AA employer, the University of Wisconsin-Extension, Cooperative Extension provides equal opportunities in employment and programming, including Title VI, Title IX, and ADA requirements. If you have a disability and require this information in an alternative format, please contact Cooperative Extension Publishing at 432 N. Lake St., Rm. 227, Madison, WI 53706; pubs@uwex.edu; or (608) 263-2770 (711 for Relay).

This publication is available from your county UW-Extension office (counties.uwex.edu) or from Cooperative Extension Publishing. To order, call toll-free 1-877-947-7827 or visit our website at learningstore.uwex.edu.

The Value of Bacillus amyloliquefaciens for Crop Production (A4114-03)