Cornell University
Cooperative Extension

Agronomy Fact Sheet Series **Fact Sheet #127**

Biologicals for Nitrogen Management

Introduction

The rise in nitrogen (N) fertilizer costs in recent years has created an interest in exploring the use of biologicals to enhance plant production, N supply and/or plant N uptake. This factsheet explains what agricultural biologicals are and describes their potential relevance to N management of field crops.

What are Agricultural Biologicals?

Although there are different ways to describe biologicals, here we define biologicals as 'living microbes, substances that alter microbial activities, or biological substances that alter plant properties (like growth and disease resistance)'.

Some agricultural biologicals currently on the market aim to increase crop production, others focus on reducing reliance on crop input such as N fertilizer or on improving soil health over time.

Types of Biologicals

There are multiple ways to categorize a large diversity of biologicals. For practical purposes, here we separate biologicals into two categories: living versus non-living (Figure 1).

Living:

Living biologicals could be *naturally occurring microbes* able to perform a function of the soil or *engineered microbes* genetically modified to provide or enhance a function of the soil. This group includes:

a. *Nitrogen fixing bacteria:*
Microorganisms that can convert N_2 from the air into forms that are available to plants using an enzyme called 'nitrogenase'. These can be naturally occurring N-fixing microorganisms or engineered microbes.

b. *Decomposers:*
Microorganisms that decompose (break down) soil organic matter and plant residues into simpler forms thereby making nutrients including N available to plants.

Non-living:

Non-living biologicals are products that are derived from living organisms (microorganisms, plants, algae, etc.) or chemically synthesized to mimic functions performed by microorganisms. Another term used for these biologicals is 'biostimulants'. Depending on the method of application they may either directly influence the microorganisms in the soil or act as a signal to promote plant growth and resistance to stress.

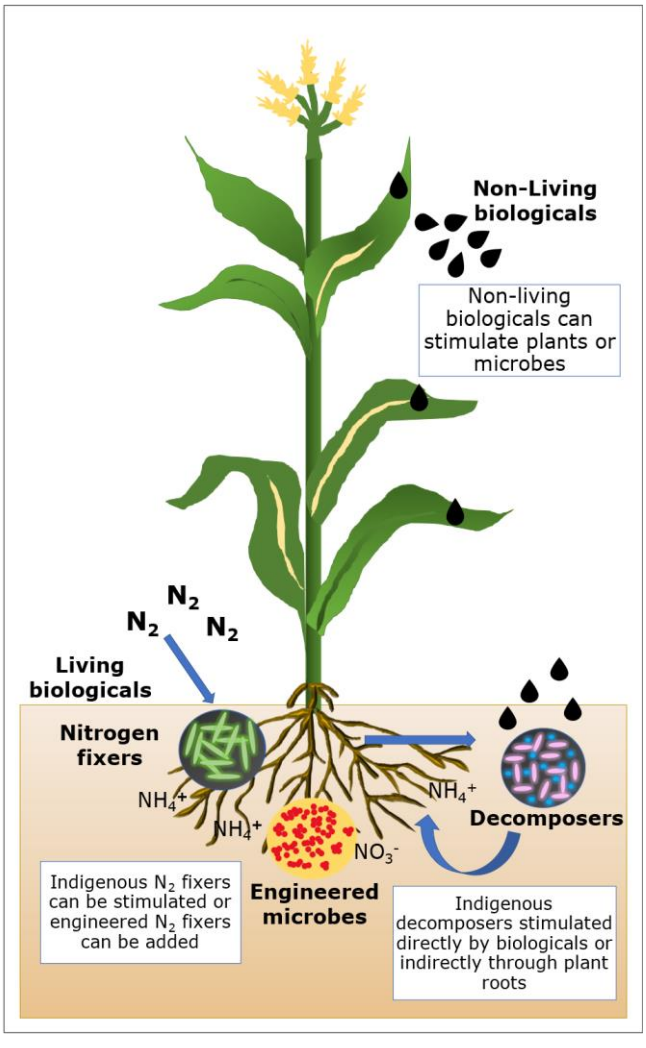

Figure 1: Categorization of living and non-living biologicals and their mechanism of action to promote plant growth, soil health, and nitrogen use efficiency.

Categories of non-living biologicals include, among others:

a. *Humic acid/fulvic acids:*
   These materials come from the decomposition of organic matter. They may enhance nutrient cycling in the soil and help boost plant metabolism and resistance to stress caused by, among others, drought, pest and/or disease pressure.

b. *Sugars:*
   Sugars are a primary source of carbohydrates in the soil and an essential organic compound for microorganisms. They may stimulate aggregate formation and act as trigger for various processes in the root zone such as N cycling and decomposition of soil organic matter.

Application of Biologicals

Biologicals can be applied in-furrow or as a seed coating, injected into the soil, as coating on dry fertilizer, or as foliar spray. The most common methods of application are in-furrow application and seed treatment as these methods ensure direct delivery of the biological. Method selection will depend on the product and its purpose of application. For some products, combining biologicals with fertilizers or herbicides can harm the biological. Thus, a farmer should take special care while considering compatibility of biologicals with other products.

Handling and Storage of Biologicals

It is important to read the label especially if a biological contains living organisms. Proper storage, handling, and application are critical. For all biologicals, it is recommended to store the product in a suitable location (cool, dry, and dark) to maintain shelf life. A uniform solution should be formed while mixing with chemical-free water and excessive downtime after mixing should be avoided. In addition to not using the prescribed application method, improper storage and ineffective mixing can also impact the efficacy of the biological.

Experimenting with Biologicals

The effectiveness of any biological will likely vary by location; local research can help evaluate what product works and what does not for a given situation.

Experimenting with biologicals on-farm should be done using research designs appropriate for the mode of operation of the biological. For example, if a biological aims to reduce reliance on N fertilizer, the appropriate research design must include a with and without comparison of the biological across 5-6 N rates, on fields that are N deficient (i.e., where a crop should benefit from extra N). If a biological is marketed to increase yield, a with and without comparison will be sufficient.

For fields harvested with yield monitor systems, the single-strip spatial evaluation approach (SSEA; see Agronomy Factsheet 124) can help evaluate if addition of a biological impacts yields across management zones.

Independent of the trial design, results may vary with soil characteristics, manure history, and weather, so experimentation on multiple fields and for multiple years will be essential.

In Summary

Biologicals are living microbes, substances that alter microbial activities, or microbial substances that alter plant properties. Product storage, handling, and application criteria must be understood before investigating the efficacy and advantages of biologicals in agricultural systems. Experimenting with biologicals may require conducting local research to evaluate their functioning.

Additional Resources

1. Sible, C. (2021) Illinois Soybean Association. https://www.ilsoyadvisor.com/webinar-understanding-biologicals-improved-soybean-management

Disclaimer

This fact sheet reflects the current (and past) authors' best effort to interpret a complex body of scientific research, and to translate this into practical management options. Following the guidance provided in this fact sheet does not assure compliance with any applicable law, rule, regulation or standard, or the achievement of discharge levels from agricultural land.

For more information

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