

Understanding Phosphorus Nutrition in Corn

- Phosphorus (P) can help corn plants increase root growth, stalk strength, crop quality, grain production, and accelerate maturity.
- The availability of P in the soil solution is relatively low and immobile, so corn plants must rely on root growth to take up P in the soil.
- Biological products are available that can help increase the amount of available P to a corn crop.

The Roles of Phosphorus

Phosphorus (P) is a macronutrient with several important roles in the growth and development of row crops. Without P, plants would be unable to grow. When plants have access to sufficient amounts of P in the soil, P can help increase root growth, stalk strength, crop quality, grain production, and maturity.¹

Energy transfer and photosynthesis. High-energy phosphate, formed as part of adenosine diphosphate (ADP) and adenosine triphosphate (ATP), provides the source of energy for multiple critical chemical reactions, like cell division and the production of new plant tissue for plant growth and development. The energy produced during photosynthesis is captured in ATP, which then becomes available as an energy source for additional chemical reactions to occur. High energy P compounds also help roots move nutrients from the soil to the plant.^{2,3}

Seed size and quantity. Phosphorus is primarily stored in seeds as phytin. Roughly 50 percent of the total P found in legume seeds and 60 to 70 percent of the total P found in cereal grains are stored as phytin or similar compounds. When the plant does not have enough P available, seed size and quantity can be reduced.² Phosphorus is essential during early plant growth and development. It helps to start germination, root development, growth, and eventual seed development.⁴

The Availability of Phosphorus

The amount of soluble or available P in the soil solution is relatively low and immobile. Corn must rely on the continual replenishment of P in the soil. The rate of replenishment can be affected by current levels of P in the soil, soil pH, and the application of P fertilizer. The dispersal of P in the soil to roots is roughly 1/8-inch per year, so crops rely on the production and expansion of

roots to take up P in the soil and the presence of mycorrhizae.^{1,5}

Plants and mycorrhizae have a symbiotic relationship in which the plant provides carbon for the mycorrhizae and the mycorrhizae provide P and other nutrients to the plant. Mycorrhizae produce a network of fungal hyphae that work to greatly expand the surface area of the roots, increasing the amount of soil volume that can be explored for P uptake. This relationship can increase the amount of P made available to the plant by 3 to 5 times the amount if no mycorrhizae were present.⁵

Crops that are deficient in P often have purple leaf margins on older leaves (Figure 1), and slow or reduced growth.¹



Figure 1. A young corn plant showing symptoms of P deficiency.

Biological Products

Acceleron® B-300 SAT. This biological product contains *Penicillium bilaiae*, a microbe that helps increase phosphate availability; helping to enhance root and shoot development and improve yield potential. *Penicillium bilaiae* is a naturally-occurring soil fungus that grows around plant roots and can solubilize P from calcium, iron, and aluminum phosphates, making P more readily available to the plant.⁶

Including *P. bilaiae* as part of a seed applied solution does not replace the need to apply phosphate fertilizer. Rather, it should be used as part of an overall fertility program to help maximize the total phosphate fertilizer investment.

Penicillium bilaiae is not crop specific, but soil responsive. The maximum benefit and yield potential response can be achieved in soils that fit the following criteria:

- Calcareous soils (calcium-based soil structure)
- Soils with low-to-medium available P:
 - Olsen < 11 ppm
 - Bray P-1 or P-2 < 15 ppm
 - Mehlich 1 < 9 ppm
 - Mehlich 2 or 3 < 15 ppm
- Soil pH levels of 7.0 or above

There may not be an additional benefit to include *P. bilaiae* on soils with organic matter above 14%, soils that have received a manure application within the last 18 months, or soils with high levels of available P.

QuickRoots®. QuickRoots technology is a microbial seed inoculant that can improve nutrient availability. The *Bacillus amyloliquefaciens* and *Trichoderma virens* based treatment helps increase availability and uptake of nitrogen, phosphate and potassium. Its ability to release nutrients from the soil helps maximize the effectiveness of agronomic inputs the yield potential of corn. The benefits of utilizing QuickRoots technology include enhanced nutrient capability, which supports root and shoot growth, increased yield potential, and performance in a variety of soil conditions and types.

Sources:

¹ Beegle, D.B. and Durst, P.T. 2002. Managing phosphorus for crop production. Penn State Cooperative Extension. Agronomy Facts 13. <http://extension.psu.edu/>.

² Functions of phosphorus in plants. 1999. Better Crops. Vol. 83.

³ The importance of phosphorus to plants. University of Nebraska. Soils - Part 6: Phosphorus and Potassium in Soil. <http://passel.unl.edu/>.

⁴ Osman, K.T. 2012. A nutrient is a chemical element needed for normal growth and reproduction of plants. Soils: Principles, Properties, and Management.

⁵ Schachtman, D.P., Reid, R.J., and Ayling, S.M. 1998. Phosphorus uptake by plants: from soil to cell. Plant Physiol. 116: 447-453.

⁶ JGI MycoCosm. *Penicillium bilaiae*. U.S. Department of Energy Office of Science. <http://genome.jgi.doe.gov/>.

Web sources verified 04/27/17. 170419094529

For additional agronomic information, please contact your local seed representative. Developed in partnership with Technology Development & Agronomy by Monsanto.

Individual results may vary, and performance may vary from location to location and from year to year. This result may not be an indicator of results you may obtain as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible. **ALWAYS READ AND FOLLOW PESTICIDE LABEL DIRECTIONS.** Acceleron® and QuickRoots® are registered trademarks of Monsanto Technology LLC. All other trademarks are the property of their respective owners. ©2017 Monsanto Company. 170419094529 051817MEC