A Summary of Corn Research Data with Magnet®

Summary

With data from 8 land–grant universities spanning over 20 years of research, Magnet has consistently shown yield increases when applied with starter fertilizers. When removing both the high and low outliers for yield, average bushels per acre increases ranged from 5.7 to 21.0. The most recent trial with the University of Missouri in 2019 showed a 16 bushels per acre increase when applied with diammonium phosphate (DAP) when compared to the treatment with only DAP. The following is an explanation and discussion of why growers see an increase when they apply Magnet with their nitrogen and phosphorus starter fertilizers.

Soil Chemistry Discussion

Because nitrogen and phosphorus play such important roles in plants (see below), they are often applied as starter fertilizers. Both of these minerals have to be in specific forms to enter the plant. In corn, nitrogen can either be taken up as ammonium (NH_4^+), or nitrate (NO_3^-). In trials with Magnet, nitrogen was typically applied as ammonium in the form of ammonium sulfate, ammonium thiosulfate, ammonium phosphate, diammonium phosphate and the like. The issue is that ammonium fertilizer can do two things in the soil: Either it goes through the process of nitrification, whereby it turns into nitrate, which is prone to leaching, or it can overload the anionic sites in the soil, which leads to potassium displacement, or the movement of ammonium further down in the soil profile away from the roots of the plants. Magnet, as an anionic (negatively–charged) polymer, adsorbs the cationic (positively charged) ammonium, keeping it in the ammonium form longer, and helping it remain in the upper part of the soil profile whereby it can be more readily taken up by the corn. This also prevents the displacement of potassium from the soil colloids, which often leads to an increase in uptake of potassium as well.

Much like nitrogen, the form of phosphorus is important to plants as well. Phosphorus must be in the form of phosphate (PO_4^{3-}, either as HPO_4^{2-} or $H_2PO_4^-$) to enter into the plant. This is why discussions as to whether the phosphorus is in the form of ortho phosphate (plant–available form) or polyphosphate (not plant–available form) is important. In trials with Magnet, phosphorus was commonly applied in the ortho–phosphate forms of ammonium phosphate or diammonium phosphate, or in the polyphosphate forms of 11–37–0, 10–34–0, and other iterations. Whether applied in the form of ortho phosphate or polyphosphate, Magnet showed an increase in yield. With the bulk of phosphorus in the soil occurring as insoluble compounds with aluminum (Al), iron (Fe), and calcium (Ca), any applied phosphorus to the soil readily precipitates with these minerals and is not available to the plant. When phosphorus is applied with Magnet, the anionic polymer adsorbs the aluminum, iron, and calcium cations, which allows the phosphorus to remain in its available form longer, leading to an increase in uptake in the plant.

Nitrogen's Role In Plants

The essential role of nitrogen is as a constituent of amino acids in plants—also known as the building blocks of proteins. Amino acids are assembled into peptides (small chains of amino acids), and into proteins (large chains of amino acids). Proteins serve a wide range of functions including structure, movement, storage, and transport. Aside from peptides and proteins, nitrogen is found in a variety of compounds, including, but not limited to: purines, alkaloids, enzymes, vitamins, hormones, nucleic acids, and nucleotides.

Phosphorus's Role In Plants

Most of the phosphorus in plants is found in ATP (also ADP and AMP), nucleoproteins, and phospholipids. ATP is an organic compound that provides energy for many different metabolic processes in plants. Nucleoproteins are defined as any proteins that are structurally associated with nucleic acids––examples include ribosomes and nucleosomes. Finally, phospholipids (lipids that contain phosphorus) are a structural double–layer component of cell membranes.

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Case Study

On April 3, 2019, the University of Missouri planted corn with applications of diammonium phosphate (DAP) at rates of 25 lbs/acre, 50 lbs/acre, and 100 lbs/acre with and without Magnet at 2 quarts per acre for each treatment—leaving 7 total treatments, including an untreated check. The corn was harvested on September 3, 2019 with the following yield data:

Untreated Check	184.99 bushels/acre
25 lbs/A DAP	180.36 bushels/acre
50 lbs/A DAP	190.27 bushels/acre
100 lbs/A DAP	186.36 bushels/acre
25 lbs/A DAP + Magnet	188.52 bushels/acre
50 lbs/A DAP + Magnet	191.97 bushels/acre
100 lbs/A DAP + Magnet	202.57 bushels/acre

Bushels per acre increased with the application of Magnet for each different application amount of DAP:

25 lbs/A DAP vs. 25 lbs/A DAP + Magnet	+8.16 bushels
50 lbs/A DAP vs. 50 lbs/A DAP + Magnet	+1.70 bushels
100 lbs/A DAP vs. 100 lbsA DAP + Magnet	+16.21 bushels

While some variability is expected in trials (due to variable field conditions), it's clear that Magnet is improving the performance and usefulness of DAP to the corn. While it's tempting to focus on the increase in uptake of the phosphorus, we likely saw an increase in uptake of the nitrogen, along with an increase in uptake of potassium and other elements as well (zinc, for example). For growers who are interested in increasing their yields, it's clear that adequately addressing the mineral needs of the plant in combination with Magnet will consistently bring the highest yields and best returns on investment.

Summary of Yield Data

Kansas State University	7–26 bushels/acre
The Ohio State University	11–15 bushels/acre
University of Arkansas	4–18 bushels/acre
University of Illinois	7–16 bushels/acre
University of Kentucky	4–19 bushels/acre
University of Maryland	5–6 bushels/acre
University of Missouri	8–16 bushels/acre
University of Wisconsin	4–21 bushels/acre

Examples Of Common Mineral Precipitates

Calcium Phosphate

$$H_2PO^{4-} + Ca^{2+} = Ca(H_2PO_4)_2$$

Aluminum Phosphate

$$PO_4^{3-} + Al^{3+} = AlPO_4$$

Iron(II) Phosphate and Iron (III) Phosphate

$$PO_4^{3-} + Fe^{2+} = Fe_3(PO_4)_2$$

$$PO_4^{3-} + Fe^{3+} = FePO_4$$

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