SeedSCOOP

# Benefits of Phosphorus for Corn Production

Modern corn products have high nutrient requirements to obtain maximum yield potential. High soil phosphorus (P) levels are essential to obtain high corn yields. Phosphorus can be one of the most overlooked nutrients where maintenance fertilizer applications may not be enough to match the nutrient uptake and removal by the corn crop. By the same token, it is a nutrient that we need to manage to prevent environmental concerns, such as eutrophication of bodies of water. Understanding the season-long importance of P in corn production and how to maintain adequate soil P levels is necessary to sustain high corn yield potentials.

## The Role of Phosphorus in Corn Production

The plant macronutrients are nitrogen (N), P, and potassium (K), which are needed by plants in relatively large quantities and most frequently required as soil amendments for maximum crop growth. Corn does not require as much P as it does N and K. A typical fertilization of macronutrients for corn in the United States is 180 lb of N, 90 lb of $P_2O_5$, and 160 lb of $K_2O$ per acre. Phosphorus is often overlooked in maintenance fertilizer applications, which can limit corn yield potential.

Phosphorus has many important roles in plants. The nutrient is involved in many metabolic functions and plays a critical role in energy reactions, such as in photosynthesis and respiration, and for the general health and vigor of plants. The nutrient also plays a vital role in plant reproduction, of which grain production is an important result. Adequate P for corn results in increased root growth, greater stalk strength, improved crop quality, uniform and earlier crop maturity, and higher grain production.

## Phosphorus in the Soil

Phosphorus exists in different forms in the soil and needs to be available in the soil solution for plants to take it up. Although there is very little P in the soil solution at any time, there is a large amount of P in most soils, the bulk of which is either tied up in soil organic matter or in soil minerals. The soil solution is replenished with residual P once plant roots remove the available P. Soil microbes transform organic forms of P in plant residues and organic matter into plant-available P through the process of mineralization. The soil solution can also be replenished from inorganic (mineral) P in the soil through processes of weathering and desorption. The rate of replenishment, which determines the availability of P, is related to P levels in the soil, its fixation by the soil, and soil pH. It can take months or years for the fixed-P to become available to the plant.

Maintaining soil pH between 6.0 and 7.0 maximizes P availability to the plant. When soil pH is lower than 6.0 in acidic soils, more iron and aluminum are available to form insoluble P compounds that are not available for plant uptake. Therefore, liming of acid soils can improve P availability. When soil pH is higher than 7.0, P can also react with calcium to form insoluble P compounds in the soil.

Phosphate fertilizers typically contain soluble forms of P that are immediately available to plants. However, soluble P in soil can react very quickly with minerals in the soil to become fixed (insoluble) and less available to plants. Generally, only about 20% of applied P is available to plants in the first year of application. The P used by a corn crop will come from fertilizer and manure recently applied as well as from such materials applied in previous years along with the residual P in the soil.

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### Phosphorus Uptake by the Crop

The uptake of P by corn depends on its availability in the soil solution and the ability of the crop to take it up. The ability of corn to take up P is largely due to its root distribution relative to the location of P in the soil. Since P is immobile in the soil, corn roots must grow through the soil to get the P that it needs. Because of fixation processes, P moves very little in most soils and stays close to its place of origin. This fixed, residual P remains in the soil and will be slowly available to succeeding crops. Corn seedlings can suffer from P deficiency even in soils with high available P levels because they have limited root systems that can be growing slowly in cold, wet, early-season conditions. Any condition that limits root growth, such as soil compaction, herbicide injury, or insect feeding, can reduce the ability of the plant to take up adequate P.

Phosphorus uptake by corn is constant throughout the growing season. Withholding P during early plant growth can limit crop production and cause a restriction in crop growth from which the plant may not recover. Field corn can show reduced grain yield due to limitations in P supply between planting and the 6-leaf stage. Early-season P deficiency can limit maximum yield potential. However, half of the total uptake of P occurs after corn flowering, and yield can be lost if P is in short supply during grain fill.

### Phosphorus Deficiency in Corn

Corn usually displays no obvious P deficiency symptoms other than a general stunting of the plant during early growth. However, young plants can become purple in color under severe stress from P deficiency (Figure 1). The degree of purpling can be influenced by the genetic makeup of the plant, with some corn products showing much greater discoloration than others. These symptoms can also be mistaken for other stresses such as soil compaction or herbicide injury. Additionally, purple coloring can also be caused by an accumulation of a purple pigment, anthocyanin, that results in the purple coloring. This can be confused with P deficiency. While not completely understood, the purpling may be the result of bright sunny days and cool nights (40 to 50° F) when plants are in the V3 to V6 growth stage. Phosphorus is highly mobile in plants, and when deficient, it can be translocated from old plant tissue to young, actively growing areas. As the plant matures, P is translocated into the reproductive areas of the plant, where high-energy requirements are needed for the formation of seeds. Phosphorus deficiency late in the growing season can affect both seed development and normal crop maturity.

***Figure 1. Phosphorus deficiency in corn, displaying a purple or reddish color on the lower leaves and stem. Older leaves are affected before younger leaves. This condition is associated with an accumulation of sugars in P-deficient plants, especially during times of low temperature.***

### Management Implications

Soil testing is the most important tool in P management as it can reveal soil P levels, soil pH, and help determine the recommended application amount of P needed for the corn crop. Fertilizer recommendations will account for both the uptake and removal of P by the crop. Each bushel of corn harvested per acre removes approximately 0.43 lb of $P_2O_5$ (phosphorus oxide). Corn cut for silage removes significantly more at 3 lb/acre of $P_2O_5$ since the majority of the above ground tissue is harvested. It is important to apply fertilizers based on the values of the soil test and apply the needed P levels based on the use of the corn crop.

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Because of P immobility and soil fixation, placement of fertilizer P can affect its availability to plants. Phosphorus fertilizer can be applied broadcast or in a concentrated band. Broadcasting and mixing P in the soil can maximize the probability of root contact with the fertilizer. At the same time, the added fertilizer is in greater contact with absorbing surfaces in the soil, thereby increasing P-fixation. Applying the fertilizer in a concentrated band can minimize contact with the soil and reduce the fixation that might occur. During the first six weeks after planting before corn plant roots reach the middle of the rows, P that is band-placed close to the corn row is more likely to be available for plant uptake than if the same amount of P was broadcast applied over the entire soil surface. Splitting the application of P between broadcast and band can help to maximize corn yields.

Since P is relatively immobile in the soil, it is mainly lost through soil erosion and runoff. Phosphorus pollution can result in excessive growth of plants and algae in water, seriously limiting the use of water for drinking, industry, fishing, or recreation. Therefore, it is important to implement management practices that minimize soil erosion and runoff both for the health of the environment and to maintain maximum plant availability of P in the soil.

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