Phosphorus and Potassium Fertility for Corn and Soybean

- In order to help achieve maximum yield potential, it is important to understand how phosphorus (P) and potassium (K) are utilized by corn and soybean.
- Skipping or limiting applications of P and K can decrease stress tolerance and consequently reduce yield potential.
- Current soil test values, crop nutrient uptake, and removal of P and K should be used to help guide fertility management decisions.

Phosphorus (P)

Phosphorus is a nutrient required in relatively large amounts by plants. It has a relatively short range of movement in the soil and is considered an "immobile nutrient", compared to nitrogen (N). Soil moisture enhances the efficacy of P uptake. Dry soil conditions can reduce uptake by the root system.

General Role of P. Plants need P for growth throughout their life cycle, especially during the early stages of growth and development. The primary role of P compounds in plants is to store and transfer energy that is produced through the photosynthesis process to be used for growth and reproduction. Adequate P levels are required to enhance shoot and root growth and promote early maturity. These effects often increase water use efficiency and yield potential. When P levels are inadequate, corn and soybean plants cannot grow, produce, or tolerate stresses. Even when soils have adequate P, plant seedlings may exhibit P deficiency symptoms as young root systems can be slow to grow due to cold, wet conditions that are common during the early part of the season. Phosphorus deficiency associated with cool soils is usually more of a concern with corn than with soybean. Soybean is generally planted when soil temperatures are warmer and plants have a more vigorous rooting system than corn.[3] Adequate P supplied to crops results in higher yield potential, improved crop quality, greater stalk strength, increased root growth, and earlier crop maturity.[3]

Critical Growth Stages. Corn plants increase P uptake rapidly after the V6 growth stage (6 visible leaf collars) of corn development, which is about 4 to 6 weeks after planting. The uptake can continue until near maturity.

In soybean, the demand for P is greatest during pod and seed development where more than 60% of P ends up in the pods and seeds.[1]

Symptoms of P deficiency in both corn and soybean include stunted plants and yellowing of the leaf margins of the older leaves. Symptoms appear first on the lower leaf tips and extend down the margins toward the leaf base. Older leaves on young corn plants may appear purple (Figure 1).[2] This condition is associated with accumulation of sugars in P-deficient plants, especially during times of low temperature. Leaf edges may become brown and lower leaves often die when P deficiency is severe, especially during hot, dry, and windy conditions. In addition, stalks may be thin and short and maturity can be delayed. Deficiency may be confirmed with soil testing for P level.

Potassium (K)

There are generally large amounts of K in the soil; however, K in the soil is not readily available for plant growth and development. Almost all of the K in the soil is involved in the structural component of soil minerals. Therefore, the amount of K supplied varies by soil type, which translates to a variation in the amount of K fertilizer needed across soil types.

Figure 1. Phosphorus deficiency symptom in corn, older leaves turn purple in color.

General Role of K. Potassium is associated with movement of water, nutrients, and carbohydrates within the plant. These functions stimulate early growth, increase protein production, and improve the efficiency of water use and resistance to diseases and insects.

Plants with insufficient K have difficulty absorbing water and N from the soil, which may increase drought stress. Corn and soybean plants conserve water and reduce moisture stress by closing the leaf stomate (opening in the leaves) mechanism, which is regulated by K.[3] Plants with inadequate K may be slower at closing their stomates, which reduces protection from drought stress. Additionally, deficient plants may have trouble making energy via photosynthesis.

Adequate K levels are important to maximize soybean yield potential. Peak absorption of K occurs from flowering through early pod development. A shortage of K during this period can result in yield loss without obvious foliar symptoms.

Stalk Rots and the Role of K. Stalk rot diseases can cause yield losses due to premature plant death and lodging. Excessive N that is out of balance with K can cause rapid growth, which may cause the plant to have insufficient structural composition to guard against fungal pathogens. The severity of stalk rot loss can be minimized with an optimum balance between K and N levels in plant tissue.[4] Potassium has been associated with improvement of stalk strength. When corn plants take up sufficient K,

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stalk drydown is moderated after maturity and the risk of lodging may be reduced.

Critical Growth Stages. In corn, K uptake increases rapidly after about the V6 growth stage, approximately 4 to 6 weeks after planting.[5] Uptake of K is completed soon after silking (R1 growth stage). Deficiency symptoms become visible when K demand becomes large and there is not enough available K.

Figure 2. Potassium deficiency symptoms in corn on outer leaf margins; first appear on lower leaves.

Symptoms of K deficiency in both crops are characterized by yellowing or browning of the leaf margins, beginning at the leaf tips, and can often be confused with N deficiency. Like N, K is mobile in the plant so older leaves are affected first (Figures 2 and 3).

Figure 3. Potassium deficiency symptoms in soybean. Daren Mueller, Iowa State University, Bugwood.org

In addition to a low soil-available K level, soil compaction and conservation tillage practices may also show deficiencies. Dry soil conditions can also negatively affect soil K uptake by plant roots.

Potassium is important in soybean plants for nodule formation and N-fixation. Deficient plants may have green stems and retain their leaves at maturity.

Managing P and K

Understanding both crop nutrient uptake and removal can help a farmer better match plant nutritional needs for a target yield in a field environment. The soil fertility levels for P and K are greatly impacted by their availability in the soil and previous crop removal. For corn, each bushel harvested per acre removes approximately 0.43 lbs/acre of P_2O_5 and 0.29 lbs/acre of K_2O.[6] For soybean, each bushel harvested per acre removes approximately 0.85 lbs/acre of P_2O_5 and 1.45 lbs/acre of K_2O. Because the majority of the aboveground tissue is harvested, crops cut for silage remove significantly more, approximately 8 lbs/silage ton of K_2O.

If there is concern about fertility, especially due to very high or very low yields, soil tests can aid with fertility decisions. In order to maintain appropriate fertility levels, soil should be tested at least every other year. It is important to apply fertilizers based on the values of the soil test.

Recommendations for P and K are equal to the amount of nutrients removed at harvest when soil test levels are in the optimum range. Residual fertility from previous crops and manure applications should be taken into consideration when determining application amounts.

It is possible to raise soil test levels if nutrient application rates exceed the crop removal rate. In general, 12 to 28 lbs of P_2O_5 and 8 to 16 lbs of K_2O above crop removal are required to raise the soil test levels one part/million for P and K, respectively.[7] The actual amount of each nutrient needed depends on the initial soil test level, soil texture, clay minerals, and organic matter level.

Sources

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