Soybean Nutrient Profile

Potassium

This nutrient profile is a part of a weekly series dedicated to the function of the 16 essential nutrients in soybean. After excluding carbon, hydrogen, and oxygen, we are left with a thirteen part series in which we will explore how nutrients are used throughout the plant as well as how to identify deficiency symptoms and develop nutrient management decisions.

In the Plant

At approximately 1-2% concentration of plant dry matter, potassium (K) is the second most common nutrient in the plant obtained from the soil. Potassium plays many roles in the plant but, unlike most other nutrients, is not a component of any biochemical compounds. Potassium occurs only in solution or bound to negatively-charged surfaces of plant tissues, which explains its high mobility in plants. Because of its presence as a cation (positively charged molecule), K is involved in regulating water and solute movement, charge balance, and osmotic and turgor pressures in cells. In other words, K helps to move and keep water and solutes where they are supposed to be based the relative concentration of K in cells.

One extremely important role K plays in plants is the opening of stomata. In the morning, an influx of K ions into the stomatal guard cells occurs causing stomata to open. This is important because this is the pathway in which CO_2 enters the plant. With a reduction in the availability of K, stomata do not function efficiently and the rate of photosynthesis and water use efficiency both decline.

Potassium deficiencies can also effect other aspects of crop management. Due to the reduced efficiency of stomata, plants will become much less drought tolerant. Water can be lost through open stomata when turgor pressure is not maintained. Plants will also become less tolerant to diseases. Leaves and pods will become sensitive to disease infestation and pod and seed can become shriveled with reduced yields.

In the Soil

Unlike phosphorus and many other plant nutrients, pH has little effect on the availability of soil K. Being a cation, K is found both in soil solution and as exchangeable K at negatively-charged soil particles bound by electrostatic attraction. This exchangeable K allows for the buffering, or replenishing, of K as it is removed from the soil solution through leaching or removal by the plant.

The majority of K movement in the soil occurs via mass flow, or the movement of a nutrient with flow of water in the soil. Once near the root system, diffusion (movement from an area of high concentration to an area of low concentration) is the main mechanism of K movement towards the roots. For this reason, soil moisture plays a large role in the availability of K. As soil moisture decreases, the water around soil particles becomes discontinuous and increases the tortuosity of the path by which K moves toward the roots.

High levels of additional exchangeable cations, such as calcium (Ca) or magnesium (Mg), can influence the amount of exchangeable K found in the soil and can potentially reduce K availability. This is mainly due to the increase in presence by these cations bound on the negatively-charged soil particles. The Basic Cation Saturation Ratio (BCSR) was developed in the 1940s to show that an ideal soil should have a certain ratio of Ca:Mg:K. Regardless of the ratio however, soil testing is the proper way to determine the adequacy of K availability in soils. Available K can be present at either adequate or deficient amounts in the soil regardless of whether the BCSR is satisfied or not. Research has shown no response to K fertilization when soil test K is adequate, regardless of the BSCR.

Figure 1. *Soybean potassium deficiency symptoms appear as chlorosis or necrosis on the leaf margins beginning with the older growth in the lower canopy. (LSU AgCenter, 2018)*

Deficiency Symptoms

Potassium, being mobile in the plant, will often show visual deficiency symptoms in the older

leaves in the lower part of the plant canopy. The most prominent symptoms will appear as chlorosis of the leaf margins (figures 1 and 2). As the deficiency progresses, chlorosis of the margins will develop into necrosis as the leaves begin to die back. As symptoms progress deeper into the leaf, interveinal chlorosis, or yellowing of the leaves between the leaf veins, will occur. The margins of the leaves will remain completely yellow with no green veins.

These visual symptoms will often be present during the reproductive stages of plant growth as potassium is being utilized in the development of pod and seed fill. Before visual symptoms are present however, deficient plants will be stunted and stems can be thin and weak. Potassium deficient soybeans are at increased risk of lodging later during the growing season.

Deficiency symptoms may also appear late during reproductive growth (R5-R6) as K is mobilized from existing vegetative tissue to developing pod and seed. It is not uncommon for these symptoms to appear on young vegetation as this mobilization will occur from the nearest source to the pod in question. These late season symptoms do not always suggest a deficiency but rather a remobilization as leaves begin to senesce.

Figure 2. *Soybean potassium deficiency symptoms appear as chlorosis or necrosis on the leaf margins. (IPNI, J. Coder, 2017)*

Deficiency Corrections

The best correction for potassium deficiency symptoms is by developing and utilizing an annual soil testing regimen prior to soybean planting. The majority of K utilized by the plant will be taken up during vegetative development even though the majority of the utilization may occur during reproductive growth. It is often the case that any steps taken to correct potassium

deficiency during reproductive growth will not improve yield. If a deficiency is apparent prior to reproductive development due to a misapplication or non-application prior to the growing season, muriate of potash (0-0-60) can be applied at soil test recommended rates. Be aware, rainfall or irrigation will be required to move K into the root zone.

Takeaways

- Potassium is essential to several functions in the plant, including regulation of stomatal openings and movement and regulation of water and solute translocation to various parts of the plant including pod and seed.
- Potassium availability is affected by soil moisture and uptake is greatly reduced in dry environments.
- Potassium symptoms appear as chlorosis and necrosis of the leaf margins and interveinal chlorosis of the inner leaf. Symptoms will appear first on older growth.
- Correction of K deficiency symptoms are difficult during the growing season, especially during reproductive growth. Potassium applications should be made prior to the growing season based on soil test recommendations.

References

Images: IPNI, J. Coder. 2018. IPNI Crop Nutrient Deficiency Image Collection. Version 2018 05-07.

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