Economic and Agronomic Considerations for K_2O Applications in Cotton

Potassium (K) fertilization plays an important role in the growth and development of cotton, and ultimately, lint yield. Recent trends of growing newer three gene BG3XF, BG3XTF, and W3FE varieties with greater yield potential tend to show K deficiency symptoms during late reproductive stages. There are multiple reasons for potassium deficiency symptoms, including environmental stress, true deficiency, high fruit retention, and source to sink relocation of K to reproductive structures.

Potassium is a mobile nutrient in the plant; therefore, deficiency symptoms first appear in the lower canopy. Visual symptoms include chlorotic mottling in the older leaves beginning at the leaf margins. Chlorotic leaf areas eventually turn necrotic and ultimately fall from the plant. Potassium uptake in cotton is slow during the early growth stages, and K demand quickly increases as root and shoot biomass develops. Most of the K uptake occurs from just prior to bloom until mid-bloom. Actively growing root tissues are responsible for obtaining both exchangeable K from the soil surface and soluble K from soil solution. Thus, only a portion of total soil K is soluble, in an exchangeable form, and readily available to plants (Reddy et al., 2022).

Figure 1. Environmental induced K deficiency due to drought stress conditions.
Brian Pieralisi, 2021

Environmental stress deficiency symptoms occur during periods of drought when the actively growing roots become callous and are less effective for scavenging potassium. Under ideal conditions, cotton banks potassium in the tissues, which allows for ample K to supply the demand of the developing bolls. This typically occurs as the plant root to shoot ratio shifts in favor of the shoots, meaning greater shoot biomass than root biomass. At this point, the plant relies more heavily on K stored within the plant tissues.

Figure 2. Environmental induced K deficiency due to drought stress conditions.
Brian Pieralisi, 2022

Also, high fruit retention and late season relocation often occur simultaneously, exceeding the plants' ability to supply K to all photosynthetic tissues, resulting in deficiency symptoms. Currently, cotton varieties can produce three to four bales of lint per acre in many growing environments in Mississippi. A combination of high fruit retention and high K demand often shows light symptomology late in the growing season with no significant impact on yield. Some examples of this could include effective plant bug management, no Thrips pressure (ThryvOn™), adequate fertility, and ample soil moisture.

The past couple of years has seen a spike in the input cost of fertilizer for cotton. Considering the price of K_2O fertilizer, it is increasingly important to soil test fields to economically manage K fertility effectively. If sampling indicates that there is $\geq$ 250lbs of K per acre in soils with high to very high K soil test levels, depending on cation exchange capacity (CEC) it is unlikely to see a yield response from K fertilizer. In this soil, there is a 20% chance of a yield response; therefore, applying fertilizer would not be economical as it is unlikely to provide additional lint yield. However, under this condition, fertilizer applications would help maintain soil fertility levels, which could be beneficial if certain economic

incentives are in place for the grower. Conversely, soils with low soil test K levels ranging from 40 to 150 lbs K per acre, depending on CEC will most likely observe a yield response. Soils with a CEC < 7 contain less soil test K than soils with > 25 CEC and still receive a medium rating (Oldham and Jones, 2022). Monitoring soil test K will allow growers to make educated decisions in K fertilizer applications. In scenarios requiring maintenance levels of K, applying reduced rates provide an opportunity to reduce fertilizer costs. Also, actively monitoring fertility levels will help avoid situations with low or very low soil test K, which is more costly to correct. It is important to consider that the best way to avoid K deficiency in cotton is to apply K_2O fertilizer to the soil rather than foliar applications.

In-season tissue sampling provides a "snapshot" of K status contained in the plant. Mississippi State University Extension recommends tissue sampling the uppermost fully expanded leaf just prior to bloom (Reddy et al., 2023). In situations where leaf tissue K ranges from marginally sufficient to deficient, leaf tissue could be measured weekly. Leaf tissue is sufficient at ≥ 3% K and marginally sufficient at 1.9% K. Leaf tissue deficiency symptoms will occur when K levels drop below 1%. Foliar K applications can raise leaf K % by approximately 20% under ideal conditions. It is important to note that only healthy tissue effectively uptakes K from a foliar application. Therefore, it is likely too late to correct with foliar fertilizer once deficiency symptoms occur. Up to 10 lbs of K foliar fertilizer can be applied weekly without burning the foliage. Also, it is recommended to buffer the solution to 4-6 ph for best results.

Figure 3. Leaf potassium expressed as percentage of K in the leaves.

Photo courtesy of Reddy et al., 2023

Optimum >3%	Marginally sufficient 1.9%	1.15 %	0.94 %	0.39 %	0.30 %

Oldham, L. and K. Jones. 2022. Nutrient management guidelines for agronomic crops grown in Mississippi. Mississippi State Extension publication. P2647. http://extension.msstate.edu/publications/publications/nutrient-management-guidelines-for-agronomic-crops-grown-mississippi

Reddy, R., H. Hodges, J. Varco, and B. Pieralisi. 2023. Potassium nutrition of cotton growth, yield and fiber quality.MAFES bulletin. Bulletin 1244.