A collaboration between:

Potassium Fixation in the San Joaquin Valley

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Location and origin of potassium fixation in the San Joaquin Valley

Reports of potassium (K) deficient plants on a wide range of soils on the east side of the San Joaquin Valley date back to the early 1960s [7]. Potassium deficiency was estimated to affect 15 to 20% of the cotton fields in the San Joaquin Valley in the early eighties [1].

In a study funded by FREP, Pettygrove and Southard developed a map showing the location of potentially K-fixing soils in the southern San Joaquin Valley using Soil Survey data and data from the CDFA cotton database [6]. The resulting map shows that the total area of potentially K-fixing soils is approximately 1.4 million acres (Figure 1). Potassium fixation was found to occur in soils formed from Sierra Nevadan alluvium, located on the east side of the San Joaquin Valley. In contrast, soils formed in Coastal Range alluvium do not fix K, except to a small extent in deeper horizons. In general, K-fixing soils are either weakly developed soils with high mica content or intermediately developed soils having high vermiculite clay mineralogy [6].

Further work by the same group revealed that vermiculite, the major K-fixing mineral in these soils, was most often found in the silt and fine-sand fractions [5]. For this reason, the relationship between soil texture and K fixation capacity was found to be weak [4].

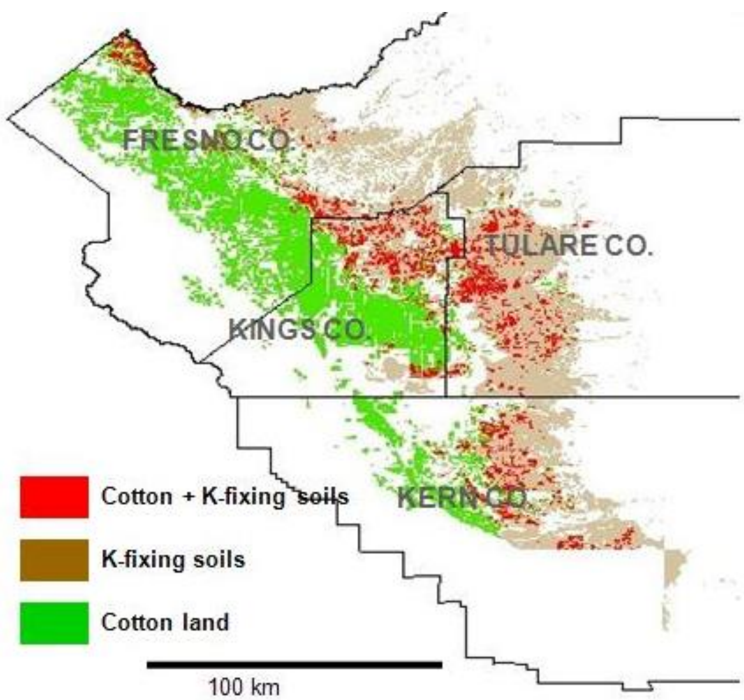

Figure 1: Potentially K-fixing soils based on model and land in cotton production at least one year during 1998-2000 [6].

Why are symptoms first visible in the younger leaves?

The deficiency symptoms generally appear late in the season, after mid-August, when the plants are about 120 days old. The symptoms of K deficiency are most severe in the youngest mature leaves [7]. This is untypical for K deficiency because K is a mobile nutrient in plants. When the K requirements of growing plant parts, such as young leaves or fruiting structures exceed the supply from the roots, K can be translocated from older leaves to the developing tissues. For this reason, K deficiencies are generally observed on older leaves first.

The uncharacteristic appearance of K deficiency symptoms in younger leaves is related to the growth cycle of cotton. During the six weeks following first bloom, cotton plants generally take up two thirds of the total amount of K taken up [2]. A large proportion of the K taken up is needed in the developing bolls, which appear be a stronger sink for K than younger leaves. Therefore, when K demand exceeds the supply from the roots and the translocation capacity from older leaves, developing leaves may suffer severe K deficiency [8]. In addition, bolls are also a strong sink for photosynthetates and other nutrients, which may lead to reduced root growth and activity.

Therefore, reduced uptake, high demand and preferential use by bolls result in the observed late-season K deficiency symptoms observed in younger leaves.

Consequences for soil testing and potassium fertilization

Based on their results, Pettygrove and Southard suggested that for cotton production, soils with exchangeable K values between 50 and 200 ppm determined by the standard ammonium extraction method and located within the area identified as potentially K fixing should be tested for K fixation [6]. Samples with exchangeable K test levels below that range always fixed K, while no samples with higher values fixed K.

In K-fixing soils, cotton plants may be deficient even when large amounts of fertilizer are added. In a study carried out in Kings county, marginally K deficient cotton was found in a field which had received an annual rate of more than 400 lbs K/acre for three consecutive years [3].

In K-fixing soils, K fertilizers should not be applied far in advance of the crops needs. In order to minimize the contact between soil and K, the fertilizer is best banded 6 to 8 inches deep. Late-season foliar applications may complement soil applied K when petiole samples or deficiency symptoms suggest suboptimal K supply.

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This document is available online at https://apps1.cdfa.ca.gov/FertilizerResearch/docs/K_Fixation_SJV.pdf

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