# SEASONAL VARIABILTY IN SOIL TEST POTASSIUM

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There has been increased interest in understanding the variability one sees in soil test potassium (K) levels within a field. Of particular interest is why after 3 or 4 years the soil test K (STK) levels are less than or greater than expected based on prior STK levels and nutrient budgets for K additions (fertilizer and/or manure) and removals (crop removal of K). It must be remembered that K availability is assessed by chemical extractions (soil tests). And any soil test only measures a fraction of the K in soil, specifically soil solution K and exchangeable K. This paper will highlight factors that affect exchangeable K and subsequently STK levels.

## Drying/Wetting

Exchangeable K can either increase or decrease upon drying and is dependent upon the clay minerals present. Potassium fixation (K becomes non-exchangeable) can occur from drying soils with high exchangeable K or recent K fertilizer applications. Fixation is a result of K becoming trapped within clay sheets as they dry and collapse. While K release (K becomes exchangeable) can occur when soils low in exchangeable K are dried because the clay sheets roll back and release K (McLean and Watson, 1985). The net effect is dependent upon whether fixation or release dominates and is dependent upon the types of clays and the amount of weathering they have undergone. Thus, the time of soil sampling in relation to field wetting and drying cycles may influence soil test K levels.

In Ap horizon soils of Ohio, Large (1969) found that air-drying on average increased exchangeable K by 14.3% compared to field moist soils. However, it must be noted that this was an average, and release and fixation were both observed. Past research in Iowa found STK increased on average about 25% when soil samples were dried at 35 to 40ºC (95 to 104ºF) (as reported by Mallarino et al., 2004). Mallarino et al. (2004) explain that their research “suggests that the effect of sample drying (and the temperature used) on extracted K varies greatly across soil series, with the soil moisture content when the sample is collected, and with other unknown factors.” These differences in STK brought on by drying soil highlight the point that it is important for all soil testing laboratories to follow the same protocol for sample handling. Following a uniform protocol, with regard to drying, will minimize using soil test data that are not valid because they deviate from conditions that were used to obtain a correlation between STK and crop yield response to fertilizer K application.

## Freeze/Thaw

In soils with considerable amounts of mica clays, freezing and thawing cycles will release fixed clay. Whereas, in soils containing smaller amounts of mica and having greater amounts of exchangeable K, freezing and thawing have no effect on K fixation/release. Thus, depending on clay mineralogy present in a soil and type of winter weather pattern, STK from samples in the spring may be different than STK from samples taken in the fall.

## Oxidation State of Iron

Iron (Fe) is a component in the structural lattice of clay minerals. Iron can be either reduced ($Fe^{2+}$) or oxidized ($Fe^{3+}$) depending upon the oxidation/reduction (redox) status of the soil. Low oxygen conditions, which may result from saturated soil, cause a change in the

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biochemical pathway of soil organisms such that $Fe^{3+}$ is reduced to $Fe^{2+}$. Shen and Stucki (1994) explain results of several studies that indicate that when the Fe in smectites (a type of clay mineral) is reduced, K fixation is increased and likely results in reduced K availability. They also showed that reduction of Fe in illites (another type of clay mineral) results in K release and increases in exchangeable K. In soils containing both smectitic and illitic clays the net effect of K fixation or release when Fe is reduced would depend upon the relative amount of each clay in the soil (Shen and Stucki, 1994).

## Clay Minerals in Wisconsin

If one were to know the dominate clay minerals in a given soil, predictions about how STK may change under different environmental conditions might be possible. However, knowing which types of clay minerals dominate in soils of different regions of Wisconsin is not straightforward because of various glacial activities throughout the state. Thus, we might expect that environmental impacts on STK may vary differently depending upon region (e.g., driftless region, eastern red soils, northern soils, and central soils) (C.A. Stiles, 2004; personal communication).

## Soil Sampling

Soil sampling must be done correctly to obtain soil test results that are representative of a field. The most intensive soil sampling recommendation is to take one sample per five acres and each sample should be comprised of 10 to 20 soil cores that are thoroughly mixed. Less intensive sampling may be done in some situations, see UWEX A2100 for details. Mallarino and Wittry (1999) reported high small scale variability in STK across fields of Iowa. Depth of sampling can also cause large differences in STK results for example if a field is sampled to seven inches one time and only five inches another time. Thus, one must recognize that if a field is soil sampled once every 3 or 4 years, the expected STK value may differ from what was actually measured, solely because of inconsistent sampling. Inconsistent sampling may include: different number of cores composited per sample, different number or location of samples within a given field, or different depth of sampling.

It must also be remembered that estimating changes in STK over time using nutrient budgets for a given field is not an exact calculation either (e.g., actual crop removal of K may be more or less than predicted). This is exactly why continued soil testing is essential to determining crop nutrient needs.

## Seasonal Variability in STK

Ebelhar and Varsa (1996) reported seasonal variation in STK over a 1-year period (Fig. 1). In 1994, the reduction in STK from June through September was attributed to crop uptake of K and possible K fixation because of drier soil conditions in August. The rebounding of STK levels after September 1994 was attributed to increased soil moisture and decomposition of crop residues releasing K to the soil (Ebelhar and Varsa, 1996). At Belleville, April 1995 was very dry and Ebelhar and Varsa (1996) felt that the reduction in STK that month was a result of K fixation brought on by dry conditions. The data shown by Ebelhar and Varsa (1996) highlight the variability in STK that could potentially be seen over the course of a year. Similar variation may be expected in Wisconsin.

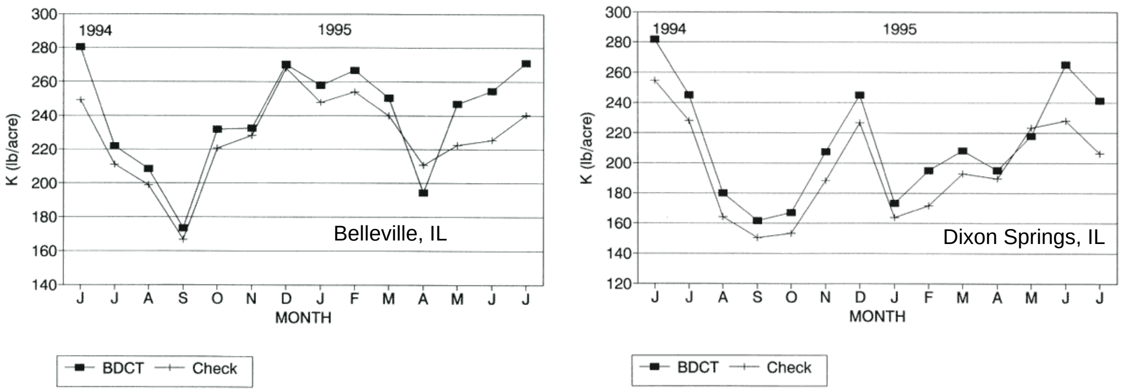


Figure 1. Soil test K levels for soils sampled monthly at Belleville, IL (left) and Dixon Springs, IL (right). On a given date at a given location, samples were composited across corn and soybean plots with the same treatment (thus, the same plots were sampled and composited each time). Treatments include: BDCT is 120 lb $K_2O$/acre broadcast prior to planting in the spring of each year; and Check is no potassium fertilization. (From Ebelhar and Varsa, 1996).

Summary

Environmental conditions such as wetting and drying along with periodic or repeated saturation, in addition to soil clay mineral composition impact STK levels. Because seasonal variation in STK is known to exist, it is recommended that soil sampling occur at about the same time of year such that seasonal variation of STK within a field will be minimized.

References


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