Potassium Dynamics in Coastal Plain Soils

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Alabama's Cullars Rotation Experiment (circa 1911) is the oldest soil fertility experiment in the South. Each year K deficiencies are observed in the "no K" treatments on 5 different crops. Shown left is cotton in early August. This site is the Marvyn l.s. in the following studies.

ABSTRACT

Potassium deficiency of crops on southern U.S. Coastal Plain soils has been known since the l880s. Long-term soil fertility studies have been conducted with K since 1911 on several Coastal Plain and related Hapludults, Paleudults, and Kandiudults in Alabama. Data from these long-term experiments allow us to answer questions such as (1) How much K can accumulate in Coastal Plain soils under cropping and fertilization? (2) Is subsoil testing necessary to obtain an accurate soil test calibration for K? (3) How much K does a crop remove from the subsoil? (4) How long does it take for crops to deplete soil test K? (5) Does soil test K vary during the year?

OBJECTIVES

Review soil test and yield data from some of Alabama's long-term soil fertility experiments in order to answer the following questions:

(1) How much K can accumulate in Coastal Plain soils under cropping and fertilization?

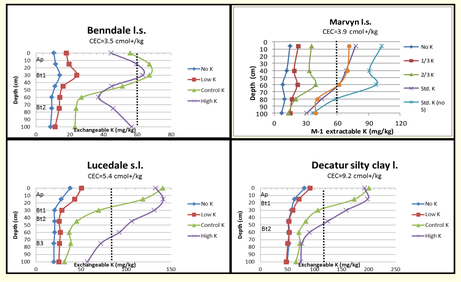
(2) Is subsoil testing necessary to obtain an accurate soil test calibration for K?

(3) How much K does a crop remove from the subsoil?

(4) How long does it take to deplete soil test K?

(5) Does soil test K vary during the year?

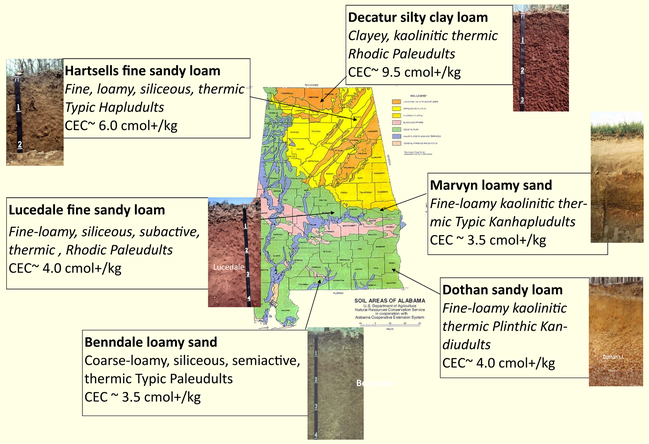
How much K can accumulate in Coastal Plain soils under cropping and fertilization?



Exchangeable K from soil profiles in 4 long-term soil fertility experiments where variable K rates have been applied for many decades indicates that K build up occurs in all horizons particularly in the surface horizons. Vertical lines indicate the current critical soil test value as used by the Auburn University Soil Testing Lab. In very sandy soils with a low CEC, surface K is barely able to reach the critical value. "Control K" and "Std. K" is about 72 kg K_2O ha^{-1} per 2-yr rotation.

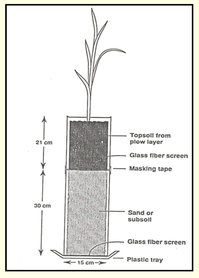
Is subsoil testing necessary to obtain an accurate soil test calibration for K?

Measuring soil K in the upper part of the argillic horizon (B horizon) did not improve soil test calibration compared to just measuring it in the plow layer (0-15 cm). The above figures illustrate this fact by comparing K in the Bt horizon with Ap horizon K.



Soil data (0-15 cm depth) have been collected for many years from some of Alabama's long term soil fertility experiments. The oldest is the Cullars Rotation experiment (circa 1911) on the campus of Auburn University (Marvyn loamy sand). Other locations on the map are from long-term experiments (circa 1929) on outlying units of the Ala. Agric. Experiment Station system. All experiments include crop rotations with soil K variables (0 to 144 kg K_2O ha^{-1} per 2-yr rotation. Crops over the years include cotton, corn, soybean, wheat and sorghum with only the grain removed.

How much K does a crop remove from the subsoil?



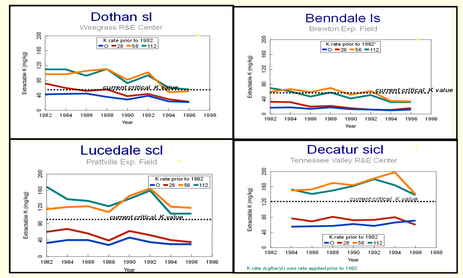
To measure K uptake from subsoils, soil from the upper 15 cm and from the argillic horizon (Bt) were collected and screened from sites with variable levels of historic K application. Soil profiles were re-created in a greenhouse study (see fig. left) using either the subsoil or washed sand. Pearl millet was grown for 40 days and K uptake measured in the herbage. No additional K was applied.

Subsoil K Uptake by Pearl Millet in 3 Alabama soils with Long-term K Fertilization Variables

	Long-term K treatment		
Soil	No K	Low K	High K
	Percentage of total K uptake from subsoil		
Benndale l.s.	21%	26%	3%
Lucedale f.s.l.	16%	31%	9%
Decatur si. c.l.	13%	30%	0%
	Mean total K uptake (mg/pot)		
Benndale l.s.	163	220	506
Lucedale s.c.l.	302	413	920
Decatur si. c.l.	359	445	684

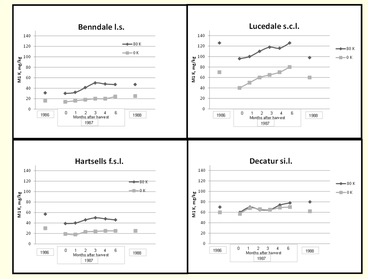
Note that in soils where "no K" or "Low K" has historically been applied, total K uptake was low due to K deficiencies but also a higher percentage of the K came from the subsoil. In the "High K" soil where topsoil K was adequate, more total K was taken up and almost all of it came from the topsoil. These data suggest that where crops are adequately supplied with K, very little will come from subsoil supplies .

How long does it take to deplete soil test K?



Potassium rates were suspended from 1982 through 1998, e.g. crops were grown using residual K only. Soil samples were collected after harvest from the 0 -15 cm depth every other year.. Mehlich-1 extractable K suggests that once soil test K is above the critical value (horizontal line on figures), more than 15 years of cropping is necessary before additional K fertilization will be needed on the finer textured soils (Lucedale and Decatur). As expected, K is depleted faster on the low CEC soils (Dothan and Benndale).

Does soil test K vary during the year?



Normally, routine soil tests are taken every other year from all plots in the long-term fertility experiments. In 1987, samples were taken monthly beginning at grain sorghum harvest in the fall and continuing until planting the following year (6 months). In most cases there was a gradual increase in Mehlich-1 extractable K as K was mineralized from crop residues. This may explain, in part, some of the variability we see in biennial soil samples that may or may not be taken immediately after harvest as in the previous long-term figures.

ACKNOWLEDGEMENTS

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