Location of Potassium-Fixing Soils in the San Joaquin Valley and a New, Practical Soil K Test Procedure

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Project Leaders
Stuart Pettygrove and Randal Southard
Department of Land, Air & Water Resources
University of California
Davis, CA 95616-8627

Cooperators
Dan Munk, UC Cooperative Extension Fresno Co., Fresno, CA
Bruce Roberts, UC Cooperative Extension Kings Co., Hanford, CA
Brian Marsh, UC Cooperative Extension Kern Co., Bakersfield, CA
Steve Wright, UC Cooperative Extension Tulare Co., Tulare, CA

Graduate Students:
Mariya Murashkina-Meese
Craig Rasmussen
Donald McGahan
Department of Land, Air & Water Resources
University of California, Davis, CA

Objectives

1. Predict soil K-fixation from soil texture and mineralogy as inferred from soil surveys.

2. Test K extraction methods for predicting K-fixation capacity on soils collected from the San Joaquin Valley.

Results of this project and a recommendation for soil testing will be made available to agricultural laboratories, crop advisers, fertilizer suppliers, and cotton growers in the San Joaquin Valley. Funding for this project is provided by the CDFA FREP and the California State Support Committee of Cotton, Inc.

Description

We have collected soil samples from 48 sites representing three categories:

1. Coarse loamy or fine loamy with coarse surface texture soils derived from granitic, Sierra Nevadan parent material (expected high K fixation potential);
2. Coarse loamy family or fine loamy with coarse surface texture derived from coastal, non-granitic parent material (expected low K fixation potential);

3. Finer-textured soils from either source of parent material (expected low K fixation potential);

Most of the sites were either in cotton production at the time of sampling or in a cotton rotation. Initially, sampling sites were selected based on map classes as defined above. Soil grab samples were collected from the 15-45 cm depth from a total of 48 separate fields in four counties (Fresno, Kings, Kern and Tulare) that received no K fertilizer in the fall of 2000, nor at any time during 2001-2002. In a reconnaissance survey at each site, three grab samples were collected 10 crop rows apart from each other. Surface texture was estimated by feel throughout the field, and at one of the three grab sample sites, texture was determined to a depth of 100 cm. Grab samples were brought to the lab, and exchangeable K^+ was extracted using 1M NH_4Cl. Locations for full profile sampling were chosen for the sites that had less than 200 mg/kg NH_4Cl-extractable K. During February-August 2002, soil samples were collected by horizons from 31 on-farm fields including at 5 trial fields. Soil pits for profile description were dug in furrows after hand-leveling cotton beds to provide a consistent reference point for depth. Selected sites representing the first soil category listed above (Sierra Nevada parent material) are mapped as Hesperia sandy loam, Grangeville fine sandy loam, Armona loam, Boggs sandy loam, Kimberlina fine sandy loam and Wasco sandy loam. Sites in the second soil category (Coast Range parent material) included Panoche loam, Kimberlina fine sandy loam, Wasco sandy loam and Milham sandy loam. Fine-texured soils sampled included Rossi clay loam, Gepford clay, Armona loam, Tulare clay, Buttonwillow clay, Panoche loam and McFarland loam.

Soil samples were separated into size fractions using a pipette method and centrifugation. Mineralogical composition of the fractions will be analyzed using a Diano XRD 8000 diffractometer producing Cu K□ radiation. The K methods (Table 1) are being performed on whole soil samples. We are testing a recently modified method for estimating plant-available K. This test, the sodium tetraphenylboron method ($NaBPh_4$), requires a five-minute incubation and routine wet chemistry techniques. This method extracts a portion of the fixed (non NH_4OAc-extractable) K that has been shown by researchers at Purdue University to be closely correlated with plant uptake of K in greenhouse studies. The greatest advantage of the $NaBPh_4$ method is that the release mechanism of nonexchangeable K in the procedure more closely simulates the extraction of this nutrient by plant roots. Other soil properties measured include pH, CEC (NH_4OAc, pH 7), and carbonate equivalent.

Results

While much of the laboratory study of this project is ongoing, the preliminary results show that sand fractions of the soils we sampled are dominantly fine sand followed by very fine and medium sand fractions. Cation exchange capacity ranges from 5 to13 $cmol_c\ kg^{-1}$ and is the highest in soils derived from Coast

Range alluvium (Table 2). The sodium tetraphenyl boron test has been performed on a few profiles so far. The highest concentrations of $NaBPh_4$-extractable K, as well as soluble and NH_4-extractable K, occurred in the Ap horizons of the Wasco and Panoche series in Kings county. The K levels in these locations were unexpectedly high, which made us think that the sites were fertilized between the time of grab-sampling and full profile sampling. The portion of plant-available nonexchangeable K that was extracted by the $NaBPh_4$ method (defined as $NaBPH_4$-extractable K minus NH_4-extractable K) in the upper horizons was the highest in the Grangeville soil (71-82%). Preliminary mineralogical studies of clay fractions showed that smectites dominate the clay fractions of Wasco and Panoche soil series, whereas clay fractions of Grangeville and Boggs soils also contain a significant amount of biotite and some chlorite. The near absence of vermiculite suggests that clay fractions probably have a low K^+ fixation potential. We speculate that the silt and fine sand fractions may contribute to K-fixation in the Sierran-alluvium-derived soils, and we are pursuing mineralogical investigations to test this hypothesis

Table 1. Summary of analytical methods for potassium study.

Method / Reagent	Form of K extracted	Procedure
K^+ Release Test (H_2O)	Soluble	7 days incubation with daily shaking for 45 min. 1:10 soil:solution ratio.
1M NH_4Oac	Soluble and Exchangeable	Vacuum extraction, 1:10 soil:solution ratio.
Tetraphenyl boron (0.2M $NaBPh_4$)	Plant-available K (soluble, exchangeable and some nonexchangeable)	Incubation for 5 min. Soil: extractant ratio is 1:3.

Table 2. Particle size distribution, CEC and soil K levels in some soils of Kings County.

Lab #	Depth,	Clay	Silt	Sand	CEC,	Extractable K+			Parent
	cm		%		$cmol*kg^{-1}$	H2O	NH4OAc	NaBPh4	material or Soil category
						mg/L	mg/kg		
Wasco: Coarse-loamy, mixed, superactive, nonacid, thermic Typic Torriorthent									
2057	0-19	15.5	18.0	66.5	12.2	12.0	516	1183	CR*
2058	19-43	13.8	17.9	68.3	11.7	9.7	456	1053	coarse
205	43-85	14.8	19.4	65.8	11.0	0.8	62	272	

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2060	85-150	13.6	12.6	73.8	10.1	1.1	68	256	
	Panoche: Coarse-loamy, mixed, superactive, thermic Typic Haplocambid								
2061	0-25	14.4	18.2	67.3	12.2	15.0	622	1315	CR
2062	25-66	12.3	16.7	71.0	11.9	1.4	108	421	coarse
2063	66-95	13.3	18.9	67.8	12.3	0.8	70	336	
2064	>95	15.7	19.4	64.9	12.3	0.6	75	306	
	Grangeville: Coarse-loamy, mixed, superactive, thermic Fluvaquentic Haploxeroll								
2065	0-19	12.6	16.1	71.3	7.2	7.8	178	621	SN**
2066	19-40	12.7	16.2	71.1	7.5	4.3	105	430	coarse
2067	40-54	10.7	17.8	71.4	7.1	2.1	49	288	
2068	54-80	9.7	17.0	73.3	NA	1.7	42	198	
2069	80-95	11.3	30.3	58.4	NA	4.0	42	165	
2070	95-110	5.3	7.5	87.2	NA	NA	17	72	
2071	110-140	5.6	2.7	91.6	NA	3.9	11	56	

* CR – Coast Ranges parent material
**SN – Sierra Nevadan parent material