Differential effects of biomass removal and soil test K (STK) level on over-winter changes in STK on five Wisconsin soils

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Introduction

Temporal/seasonal differences in STK have been recognized for some time, but have not been quantified for Wisconsin soils. Currently, the University of Wisconsin-Extension does not specify what time of the year soil sampling should be done, but suggests that soil should be sampled consistently at the same time of the year. If fluctuations in soil test K levels can be attributed to a particular time of the year or to particular weather/ environmental conditions, then soil test interpretations could potentially be improved. Of particular interest is whether soil test levels change significantly between the fall and the spring, since these are the times when soil is sampled most often.

Objectives

I. Quantify how much STK levels change over-winter at five Wisconsin locations
II. Evaluate the effect of STK levels on the over-winter change in STK
III. Evaluate the effect of corn harvest management system (grain or silage) on the over-winter change in STK

Materials and Methods

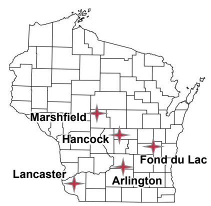

Figure 1. Location of field sites in Wisconsin.

Field sites

- Field plots were established in the spring of 2006 (Figure 1)
- Selected soil characteristics presented in Table 1
- The sites were cropped in a corn-soybean-corn rotation
- Plot size was 3.0 m in width (Hancock was 3.6 m) and 10.6 m in length
- The experimental design was a split-plot with four replications
- Corn harvest management system (HMS) was the whole plot factor (corn grain and silage)
- Potassium fertilizer rate was the subplot factor (0, 62, 125, 187, 249, 311, and 374 kg K ha^{-1} rates at all locations except Fond du Lac, which only received the lesser four K rates)
- Potassium fertilizer was preplant surface broadcast and incorporated in 2006 only
- Tillage was spring or fall chisel (moldboard at Hancock)
- Best crop and pest management practices were followed

Soil sampling and analysis

- Sampling occurred post-harvest in the fall and preplant in the spring
- Six, 0 to 20 cm soil cores were composited from each plot
- Soil was homogenized, sieved to 2 mm, oven-dried at 35°C, extracted with Bray-1 for K, and analyzed by atomic absorption or ICP-OES

Data analysis

- The over-winter change in STK was calculated as: spring STK minus fall STK
- Soil test K levels for each location and over-winter period were divided into four groups (quartiles)
- The effects of STK quartile and HMS (and their interaction) on the over-winter change in STK were evaluated with a mixed model ANOVA

Table 1. Selected characteristics of soils

Location	Soil name	Taxonomic name	Initial Soil Test Values			
			K †	P †	pH	OM
			mg kg^{-1}			%
Arlington	Plano sil	Fine-silty, mixed, superactive, mesic Typic Argiudolls	123	33	6.7	4.0
Hancock‡	Plainfield s	Mixed, mesic Typic Udipsamments	40	97	6.6	0.8
Lancaster	Fayette sil	Fine-silty, mixed, superactive, mesic Typic Hapludalfs	70	12	6.9	2.7
Marshfield	Withee sil	Fine-loamy, mixed, superactive, frigid Aquic Glossudalfs	111	32	7.1	3.4
Fond du Lac	Kewaunee cl	Fine, mixed, active, mesic, Typic Hapludalfs	95	17	7.6	3.2

† Bray-1 extracted K and P.
‡ Irrigated.

Results

Table 2. Range in STK levels at each location and over-winter period and results of ANOVA analysis evaluating the effect of STK quartile and HMS on the over-winter change in STK

Over-winter period	Location	Range in STK levels		Main effect			
		Lower	Upper	STK quartile		HMS	
				P-value	$LSD_{0.05}$	*P*-value	$LSD_{0.05}$
		— mg K kg^{-1} —					
2006 to 2007	Arlington	87	241	<0.0001	13	<0.0001	9
	Hancock	16	62	0.0296	11	0.5610	NS
	Lancaster	55	128	0.1689	NS	0.8089	NS
	Marshfield	87	264	<0.0001	13	0.0741	NS
	Fond du Lac	84	128	0.7448	NS	0.5038	NS
2007 to 2008	Arlington	80	206	0.0118	11	0.0017	8
	Hancock	23	55	0.0627	NS	0.6098	NS
	Lancaster	55	142	0.3292	NS	0.0201	6
	Marshfield	92	200	<0.0001	8	0.5204	NS
	Fond du Lac	94	127	0.0012	6	0.0143	4

- At Arlington and Marshfield STK decreased over-winter for greater STK quartiles and increased over-winter for lesser STK quartiles. This trend varies at Marshfield in 2006-2007.
- Soil test K at Lancaster and Fond du Lac mostly increased over-winter in 2006-2007.
  - More decreases in STK occurred over-winter at these locations for the greater STK levels in 2007-2008.
- Previous mineralogical analysis of soil series (or related soil series) at Arlington, Marshfield, Lancaster, and Fond du Lac found layer silicate minerals (micas, vermiculites, and smectites), which would have the ability to fix and/or release K (Glen et al., 1960; Chapman, 1970; NRCS, 2010).
- Consistent and significant increases of approximately 10-25 mg K kg^{-1} occurred at Hancock both years and this did not depend on STK quartile or HMS.
  - Cannot be explained with knowledge of clay minerals at this location because the soil is 89% sand (i.e., there is likely to be a minor amount of clay minerals present); previous literature suggests the clay fraction is high in weathered minerals like chlorite (Jackson, 1957); and the soil has a relatively low nonexchangeable K content.
- In the 2006-2007 over-winter period, Arlington is the only location where HMS significantly effected the over-winter change in STK.
  - This is attributed, at least in part, to the greater K uptake that occurred at Arlington relative to the other locations.

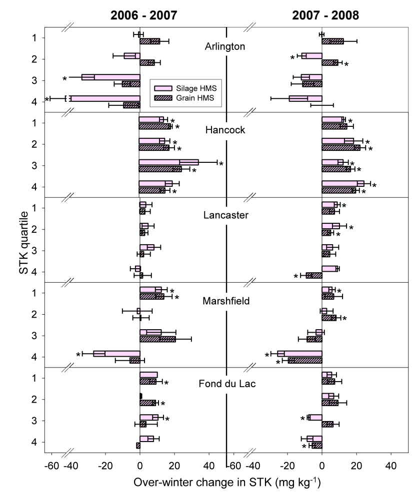

Figure 2. Over-winter changes in STK (spring STK minus fall STK) for each STK quartile and harvest management system (HMS) for five Wisconsin locations in 2006-2007 and 2007-2008. STK quartile 1 represents lower 25% of STK levels; STK quartile 4 represents upper 25% of STK levels. Asterisk indicates that the change was significantly (P<0.05) different than 0. Error bars indicate plus or minus one standard error.

Conclusions

- Over-winter changes in STK were not entirely consistent from year to year and between STK levels within a given location at Arlington, Lancaster, Marshfield, and Fond du Lac; however, consistent and unexpected increases occurred at Hancock.
- The results suggest that it is not possible to improve STK interpretations to account for seasonal fluctuations caused by environmental conditions. Therefore, if possible, soil should be consistently sampled at the same time of the year.