Effects of soil moisture and drying conditions on extractable K in Kansas soils

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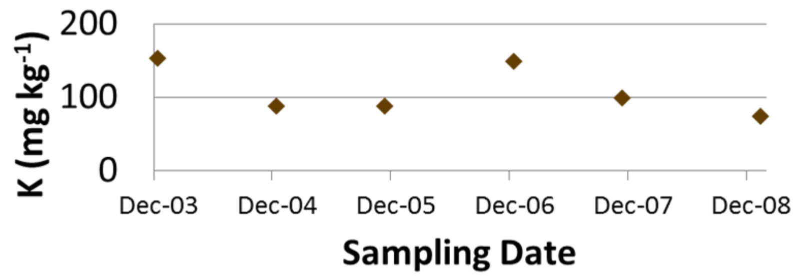
Introduction

- Potassium (K) is an essential nutrient for plant development, and in recent years, an increasingly expensive fertilizer input—thus increasing the importance of accurate soil test results in making agronomically and economically prudent nutrient management decisions.
- In parts of southeast Kansas, soil K test results have shown inexplicable swings from year to year (Fig. 1) and have been poorly correlated with fertilizer response.

Fig. 1. History of Soil Test Results at Delmont (SE KS)



Objectives

- Evaluate the effects of drying time, drying temperature, soil moisture content, and wetting-drying cycles on extractable K on southeast Kansas (SE KS) versus northeast Kansas (NE KS) soils.
- Determine the significance of these effects in the SE KS K fluctuation issue.
- Determine clay mineralogy of soil samples to help explain effects.

Sites and Methods

- Soil samples were collected from the upper 15 cm of four Cherokee county (SE KS) sites exhibiting unusual K behavior and three Riley county (NE KS) sites with more typical K behavior.
- Each of the following treatments was replicated three times. After each of the treatments, the samples were extracted with 1M ammonium acetate. Extracts were analyzed by flame atomic absorption spectrophotometry.

Drying time study

10 g moist soil
- Dried at 40°C for 1 day
- Dried at 40°C for 2 days
- Dried at 40°C for 3 days
- Dried at 60°C for 1 day
- Dried at 60°C for 2 days
- Dried at 60°C for 3 days

Drying temperature study

10 g moist soil
- Left "field moist"
- Air-dried for 3 days
- Dried at 40°C for 3 days
- Dried at 60°C for 3 days
- Dried at 80°C for 3 days
- Dried at 100°C for 3 days

Moisture conditions and wetting and drying cycles study

20 g air dried soil
- Taken to 10% GWC and sealed (constant moisture)
- Taken to 15% GWC and sealed (constant moisture)
- Taken to 20% GWC and sealed (constant moisture)
- Taken to 20% GWC and left exposed (variable moisture; rewetted to 20% GWC weekly)

Samples incubated at 30°C and extracted at 1 day, 1 week, 4 weeks, 8 weeks, 12 weeks, and 16 weeks.
Prior to extraction, samples dried for two days at 40°C.
GWC = gravimetric water content.

- Clay mineralogy was determined via X-ray diffraction.
- Data were statistically evaluated by procedures (PROC GLM) for ANOVA provided by SAS.

Table 1. Classification and location of sampled soils

Sample ID	Location	Soil Series	Taxonomic Class
Delmont (DEL)	Cherokee County, KS	Cherokee	Fine, mixed, active, thermic Typic Albaqualfs
Jennings (JEN)	Cherokee County, KS	Cherokee	Fine, mixed, active, thermic Typic Albaqualfs
SE Brown (SEB)	Cherokee County, KS	Cherokee	Fine, mixed, active, thermic Typic Albaqualfs
SW Brown (SWB)	Cherokee County, KS	Cherokee	Fine, mixed, active, thermic Typic Albaqualfs
Ashland (ASH)	Riley County, KS	Belvue	Coarse-silty, mixed, superactive, nonacid, mesic Typic Udifluvents
North Farm Top (NFT)	Riley County, KS	Smolan	Fine, smectitic, mesic Pachic Argiustolls
North Farm Bottom (NFB)	Riley County, KS	Kennebec	Fine-silty, mixed, superactive, mesic, Cumulic Hapludolls

Results and Discussion

Fig. 2. Effects of drying time at 40°C and 60°C on extractable K

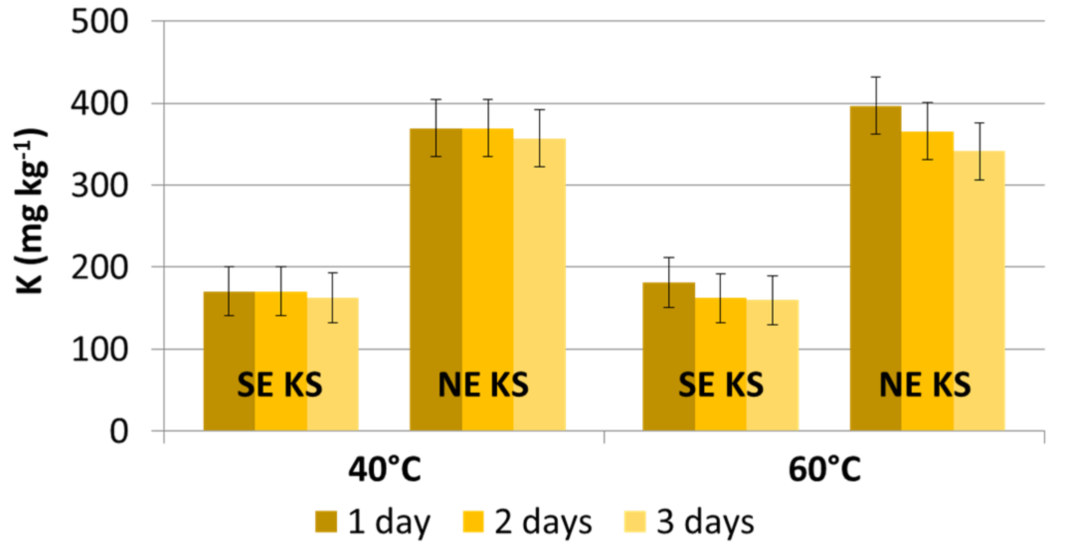


Fig. 3. Effects of drying temperature on extractable K

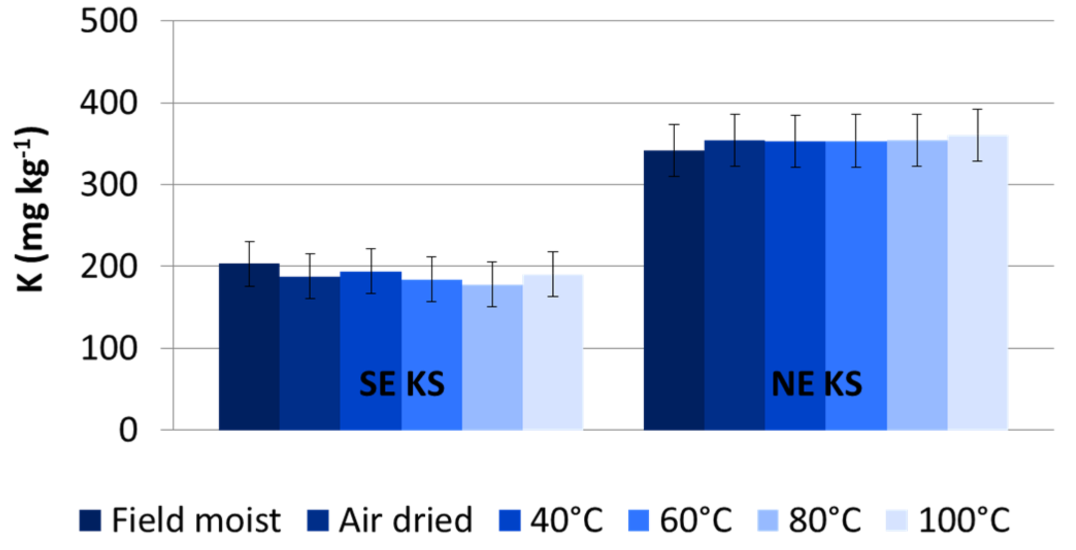
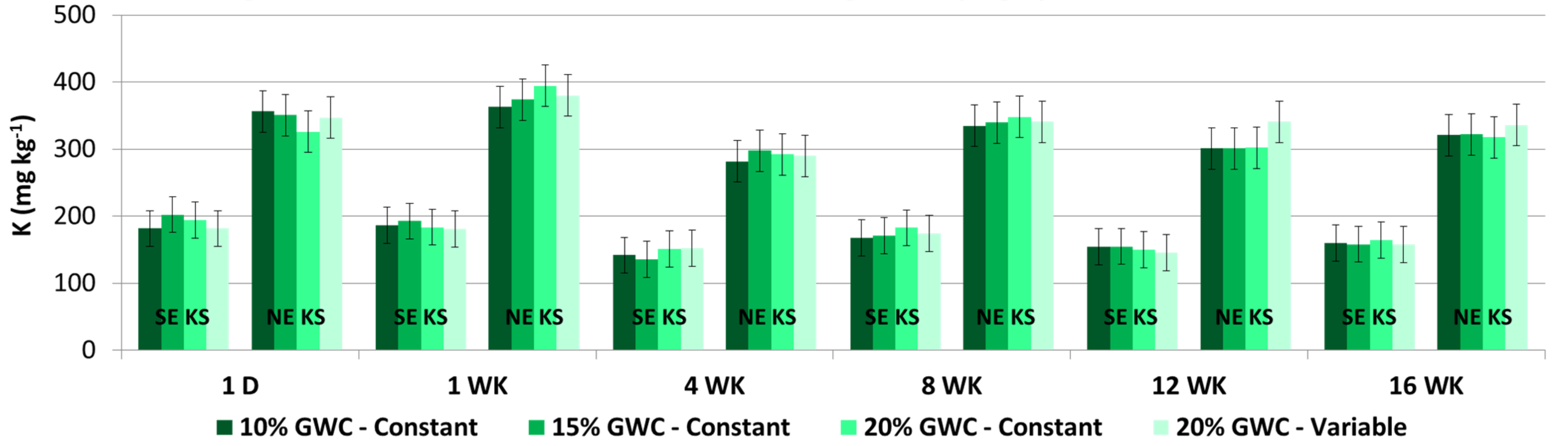


Fig. 4. Effects of moisture content and wetting and drying cycles on extractable K



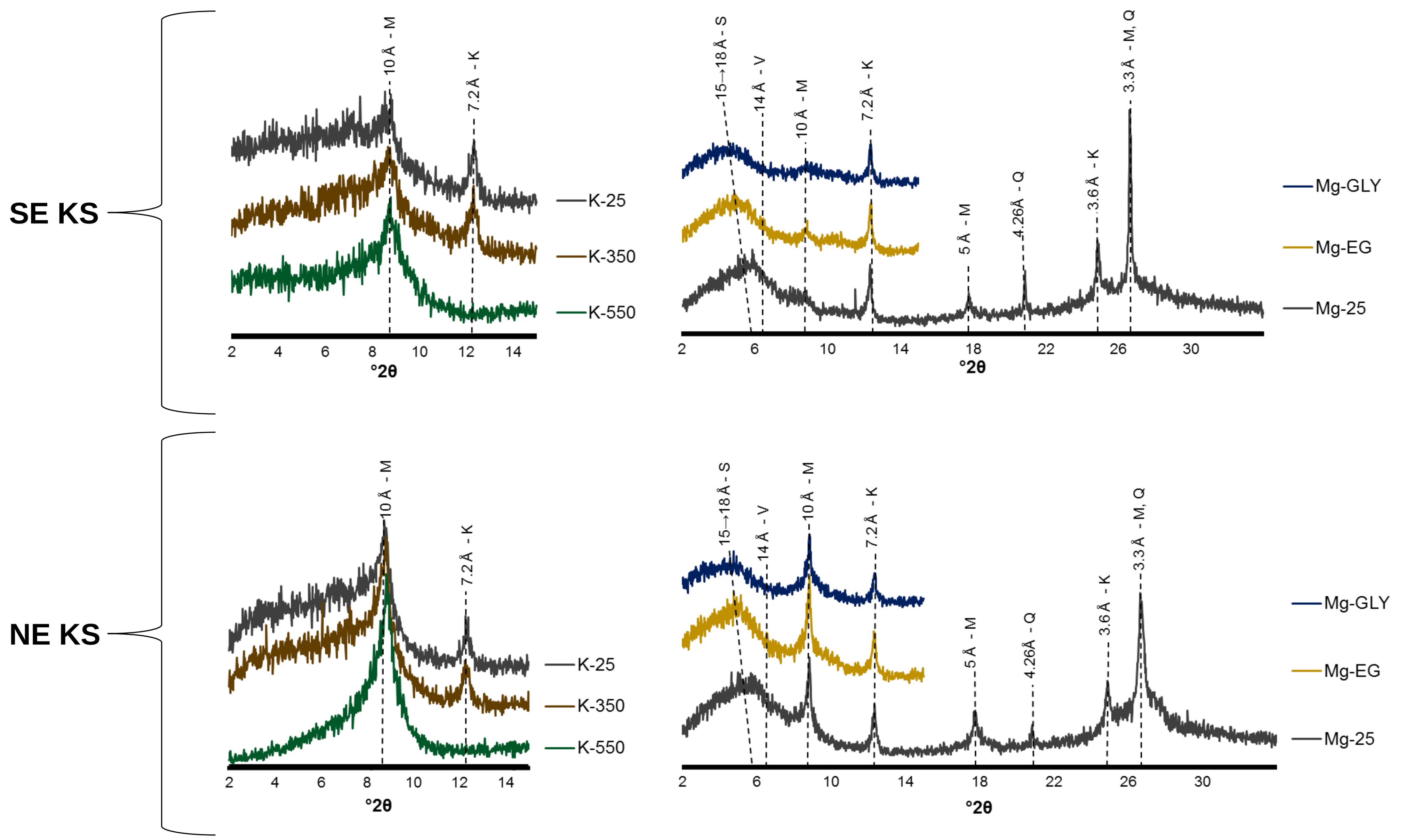
- There were statistical differences between most of these treatments for individual sites. However, the absolute magnitude of these differences were inconsequential in the context of soil management.
- With increased drying time, each soil demonstrated a decrease in extractable K. Excepting this pattern, no other pattern was apparent between treatment and extractable K.
- The individual sites were aggregated into regions due to their similarities in soil characteristics and response to treatments.
- When averaged by region, the differences in extractable K are insignificant as indicated by the standard error bars in Figures 2, 3, and 4.

Table 2. Particle size distribution, textural class, and pH of studied soils

Sample ID	Clay (%)	Silt (%)	Sand (%)	Textural Class	pH in H_2O (1:1)	pH in 0.01M $CaCl_2$ (1:2)
DEL	10.5	85.1	4.4	Silt	6.3	5.5
JEN	15.7	63.8	20.5	Silt loam	6.3	5.6
SEB	12.6	79.2	8.2	Silt loam	7.2	6.6
SWB	11.2	80.7	8.1	Silt	6.3	5.4
ASH	11.1	30.9	58.0	Very fine sandy loam	5.4	5.0
NFT	35.2	54.7	10.1	Silty clay loam	5.1	4.5
NFB	26.4	61.2	12.4	Silt loam	7.3	6.5

Results and Discussion (continued)

Fig 5. Representative XRD patterns of the K-saturated and Mg-saturated clay fraction of both SE KS (top, SWB) and NE KS (bottom, NFB) soil samples. K-saturated samples were dried at 25°C, 350°C, and 550°C. Mg-saturated samples were all dried at 25°C, with some being solvated with glycerol (Mg-GLY) or ethylene glycol (Mg-EG). Minerals: S—smectite, V—vermiculite, M—mica, K—kaolinite, Q—quartz



- Clay mineralogy was mixed for all soil samples. The SE KS samples exhibited more vermiculite whereas the NE KS samples contained more mica.

Conclusions

- Varying soil drying time, drying temperature, and moisture condition had a negligible effect on soil extractable K.
- These results suggest that the K fluctuations observed in SE KS are predominately a field and not a laboratory phenomenon.
- Future work on the variation of extractable K in Kansas soils should concentrate on K behavior and management in the field, rather than differences caused by the treatment of samples in the laboratory.
- However, further study of the relationship between moisture, fluctuating pH, and extractable K in the laboratory may provide some insight into the mechanisms driving field-level K fluctuations.
- Future laboratory investigations will include determining the mineralogy of the silt fraction of these soils and the effect of artificially reducing and oxidizing these soils on extractable K.