Module 4: Potassium Management

To view the chapter for this topic click here.

Introduction

- Potassium (K) is abundant in most soils, but the vast majority is unavailable to plants.

- Plants require K for:
  - photosynthesis
  - synthesis of ATP (an energy exchange compound)
  - synthesis of many carbohydrates and proteins
  - translocation of sugars
  - nitrogen fixation in legumes
  - strength of plant stalks and stems
  - resistance to several diseases

- K-deficiency symptoms:
  - yellow or white spots on the leaf edges (in alfalfa)
  - chlorosis and necrosis of older leaf edges (in corn and soybean)
  - chlorosis of leaf tips (in wheat)

Potassium Amounts in Harvested Portions of Crops

Crop	Unit of Yield	Pounds K_2O per unit of yield
Corn	bu	0.3
Corn silage	bu grain equivalent	1.3
Soybean	bu	1.5
Oat and Straw	bu	1.0
Wheat	bu	0.3
Sunflower	100lb	0.7
Alfalfa	ton	40
Tall fescue	ton	66
Source: Iowa State University Extension publication PM 1688.		

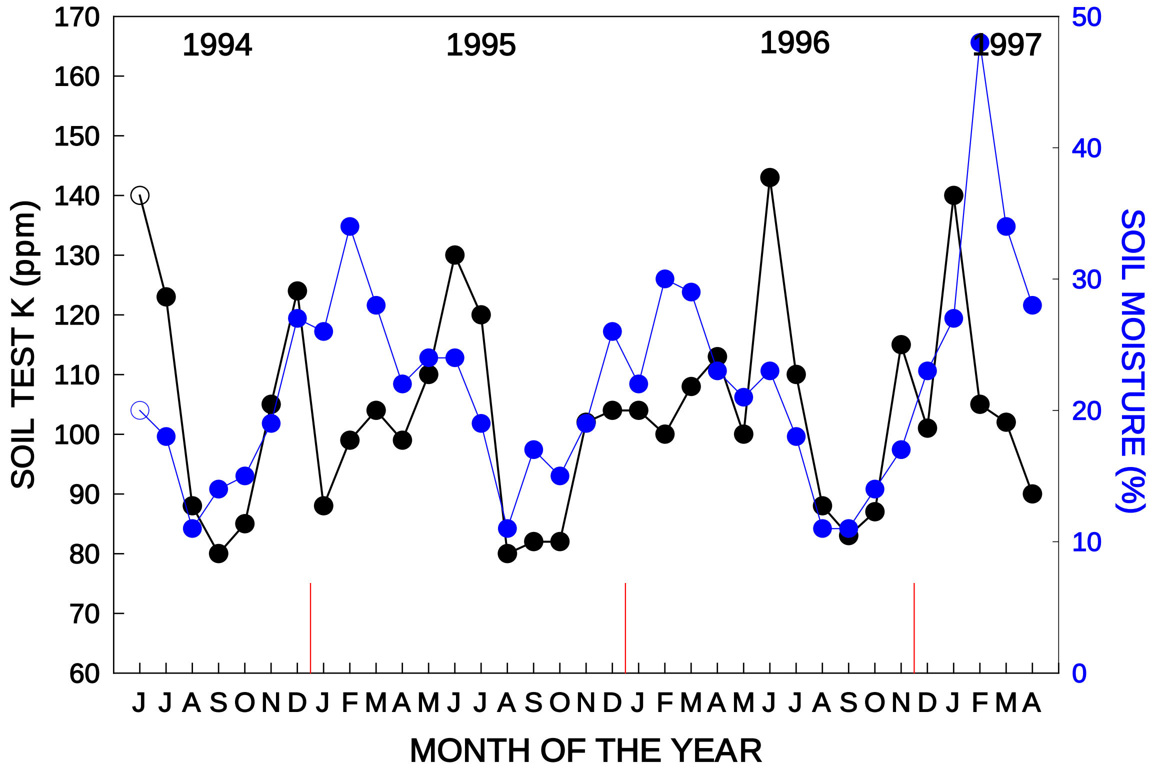
Potassium Soil Testing

- The goal is to estimate the supply of K available to a crop.
- Amount of K in solution is very small, therefore, exchangeable K is the most important pool to measure since it should replenish K in solution as plants take up K.
- The soil-test K methods used in the U.S. approximately estimate exchangeable K, and also include the very small amount of K present in the soil solution.
- Most common K extractants:
  - ammonium acetate
  - Mehlich-3
  - some states use the Bray-P1, Morgan, or Mehlich-1
- Extracted K is measured by atomic absorption or ICP (inductively coupled plasma), which give similar results.

Understanding Temporal Potassium Soil-Test Variability

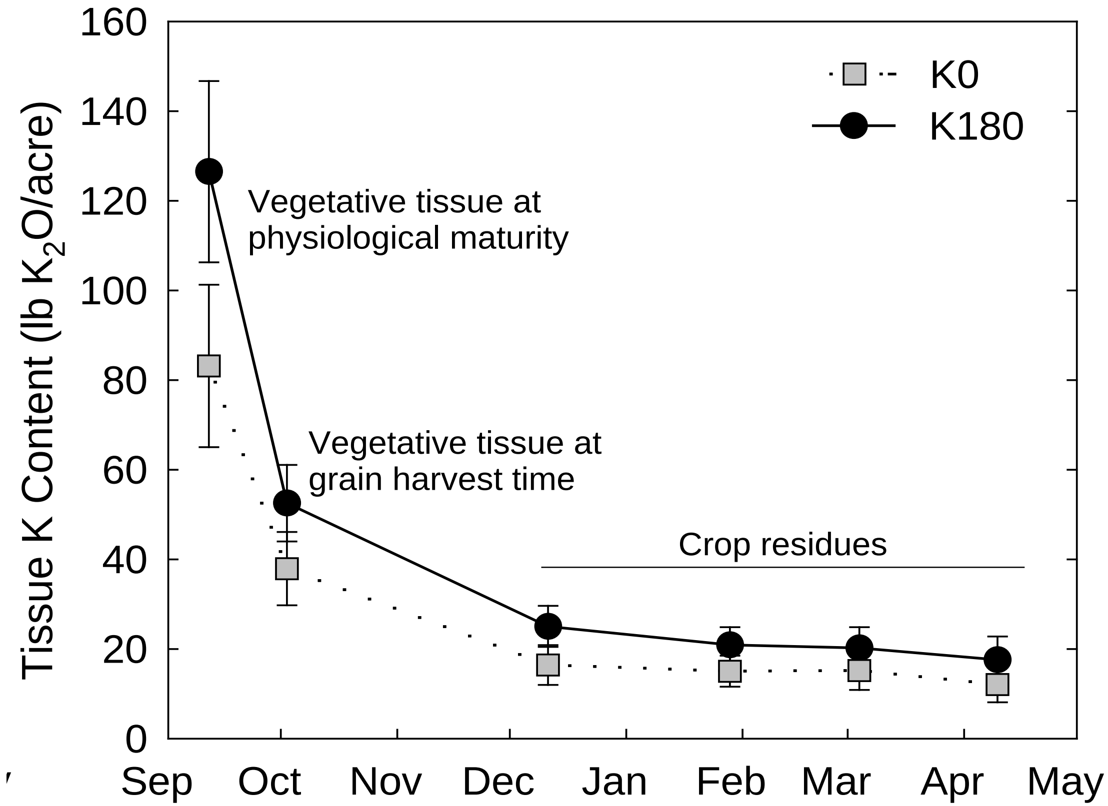
- High temporal variability in soil-test K from harvest of one crop to planting of the next is often associated with slow equilibrium between soil K pools, precipitation, and soil wetting and drying:
  - Variation in soil moisture can make soil K less or more crop available by affecting the equilibrium between exchangeable and non-exchangeable K pools
  - The timing and amount of K recycling from crop residues is affected by rainfall
- The effects of these processes on soil-test K is difficult to predict
- Reasons for soil-test K variation over time need to be considered when deciding the time of soil sampling and when interpreting results.
- Consistency in the time of the year when soil samples are collected is recommended.

Temporal variability of Potassium Soil-Test



Relationship between soil moisture and soil-test K levels over time in a Southern Illinois soil. Adapted from T. Peck (moisture) and S. Ebelhar and E. Varsa (soil-test K), University of Illinois.

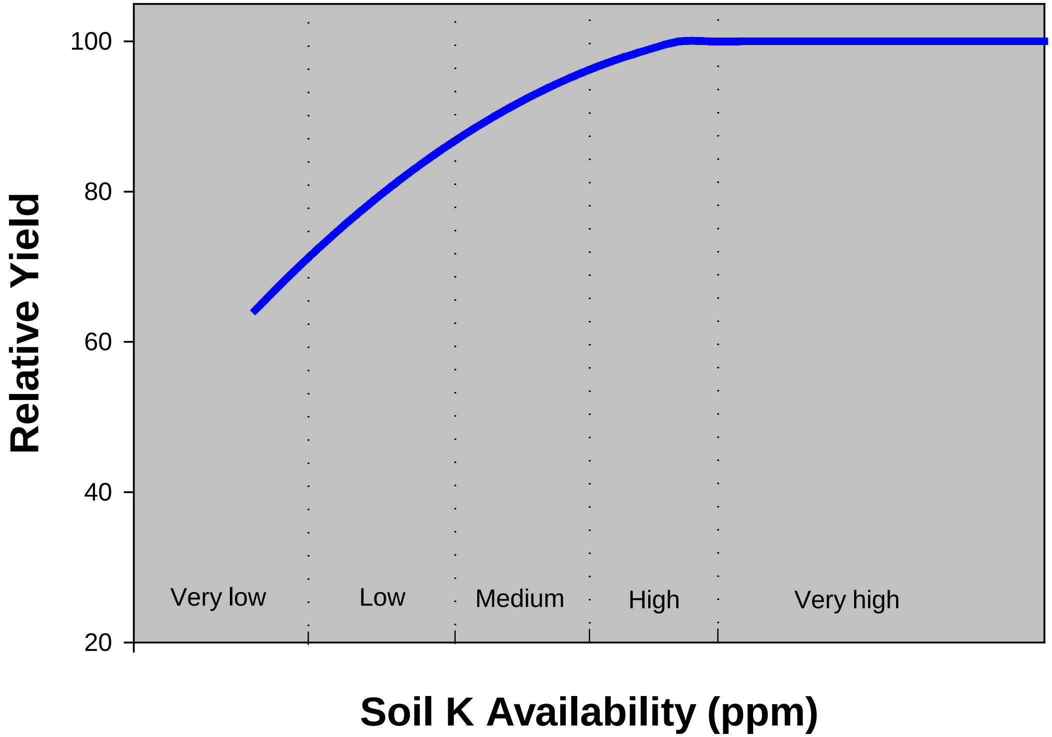
Potassium Soil Testing



Concentration and amount of potassium in soybean plant tissue (except grain) over time for two K application rates (averages across 11 sites). Adapted form R. Oltmans and A.P. Mallarino, Iowa State University).

Potassium Interpretation and Recommendation Concepts

- The interpretation of test results and recommended fertilization rates vary across regions.

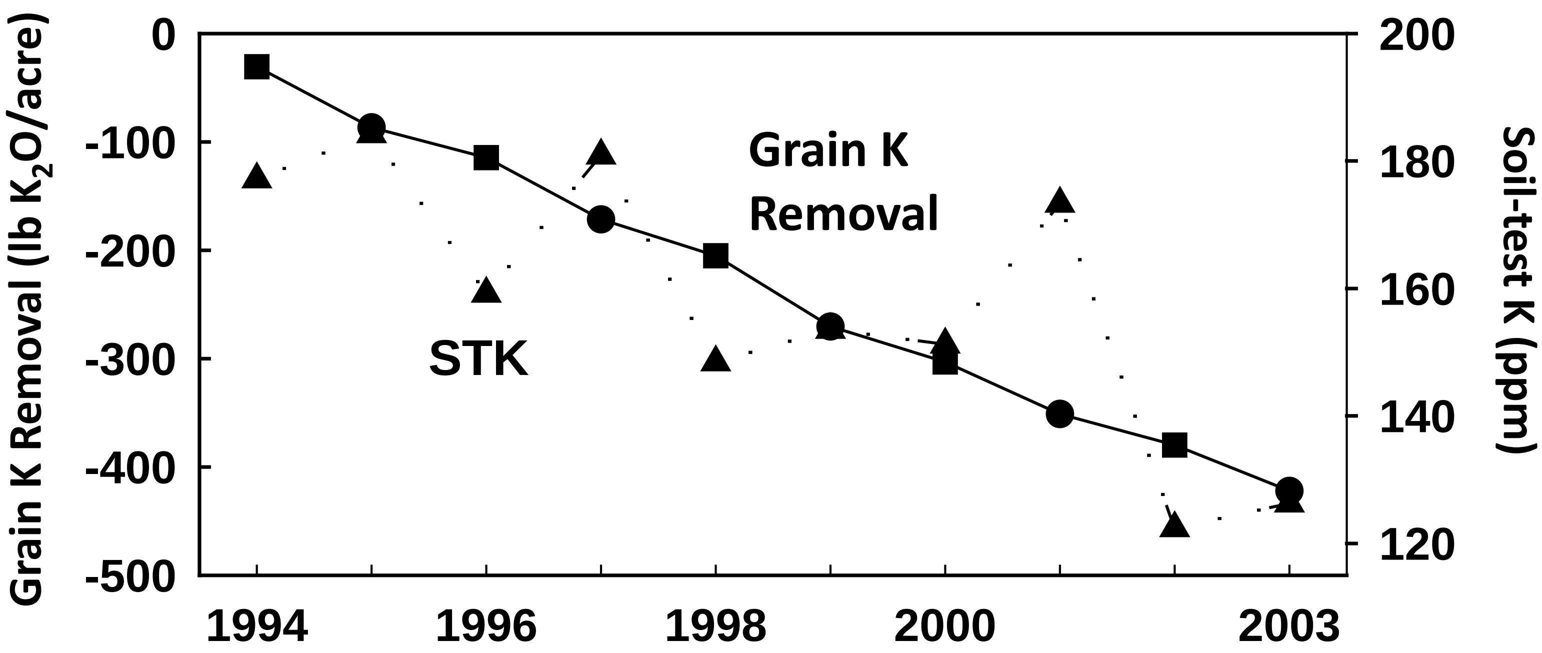


General relationship between crop yield response to K addition and soil-test K level interpretation categories (the medium category often is referred to as optimum).

Potassium Interpretation and Recommendation Concepts

- Recommended approach in much of the U.S.:
  - Potassium application if soil test K is in the very low or low categories; applications will increase soil test K to the medium level (often referred to as optimum).
  - Appropriate K rates depend on soil-test K category, consideration of removal with harvest, and crop/fertilizer price ratios.
  - Consideration of the amount and time needed reach the optimum soil test level, but varies.
  - Maintenance of desirable soil-test K values based on crop removal.
  - The goal often is to increase to and keep soil-test values at the optimum category, where the probability of large crop responses is low.

Potassium Soil Test K with Grain Removal



Soil-test K and cumulative K removal long-term trends for the average of five Iowa sites. Adapted from A.P. Mallarino, Iowa State University.

Potassium Sources

- Potassium chloride (KCl, 0-0-60)
- Potassium sulfate (K_2SO_4, 0-0-50)
- Potassium nitrate (KNO_3, 13-0-44)
- Potassium in manure and biosolids

Application Method and Timing

- Band applications concentrate nutrients at or near the root zone (important in cold and/or compacted soils).
- The "starter" effect from K is much less than for N and P.
- Banded K should be placed beside and below the seed level to reduce potential damage or by using very low rates if seed placed.
- Band K applications are recommended in soils with strong capacity to retain K.
- Deep banding K can be more effective for ridge-till and sometimes no-till, where K tends to accumulate at or near the soil surface.
- Timing of K application typically has little or no impact on K use efficiency by crops; except in the rare soil with very high K fixing capacity.

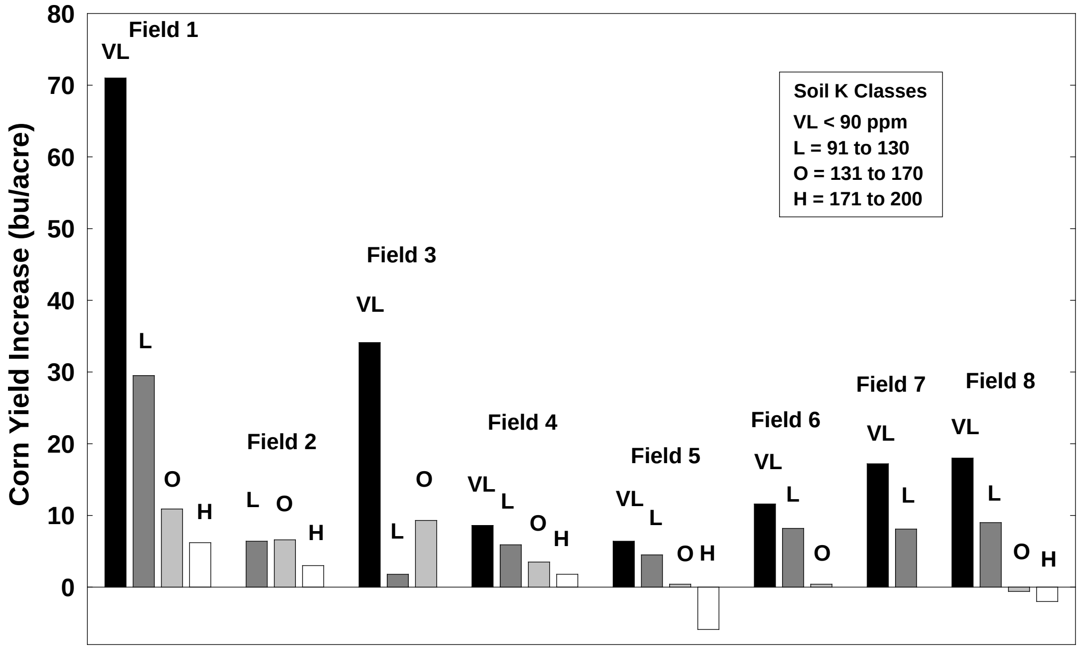
Variable Rate Potassium Application

- Dense or zone soil sampling in many fields has shown very large within-field spatial variability of soil-test K, crop yield levels, and crop response to K.

- Precision agriculture technologies and variable-rate application facilitate application of fertilizer and manure at rates adequate for different parts of a field.

- Variable-rate technology:
  - may not always increase crop yield or increase profits; depends on soil-test K values and variation
  - minimizes or avoids K application to high-testing areas within fields
  - reduces soil-test K variability
  - improves K use efficiency

Variable Rate Potassium Application



Within-field soil-test K variability and yield response variability from eight representative strip trials conducted in Iowa. Adapted form A. P. Mallarino, Iowa State University.

Management Practices for Potassium Fertilization

- Sample soil as frequently and densely as economically possible (every 2 to 4 years), and use appropriately calibrated soil-test methods.
- Consider yield levels and crop removal to help maintain optimum soil-test K levels and account for crop available K applied with manures and other organic sources.
- Fertilize K deficient soils using economically sound agronomic guidelines.
- Divide large non-uniform fields into smaller fertility management units based upon yield potential, soil tests, and relevant soil properties.
- Refer to local research and guidelines concerning K placement methods to optimize K use efficiency and the profitability.
- Increased K crop use efficiency and economic return can be achieved with the right rate, placement, timing, and source that is appropriate for each situation.

Summary

- Proper management of K is essential to maximize the profitability and efficiency of a non-renewable resource.

- Although there is large temporal variability of soil-test K and uncertainty with soil testing, soil sampling and testing for K is a useful diagnostic tool.

- The goal of sound K management should be to keep the soil-test K level at optimal ranges.

- Substantial within-field variability of soil-test K and K removal with harvest in most agricultural areas justifies the use of precision agriculture technologies.