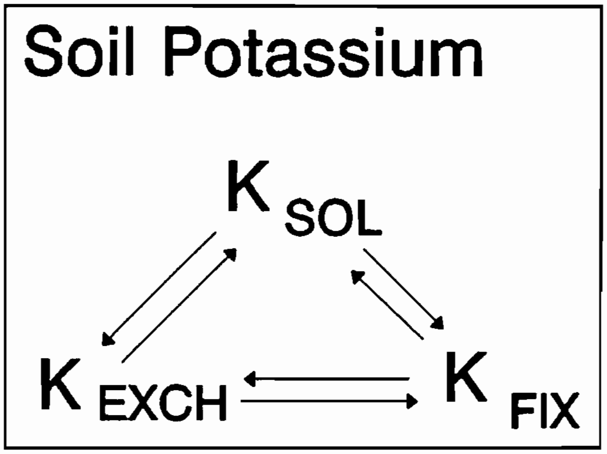
Potassium Recommendations

Jay W. Johnson
Ohio State University

Most soils have relatively large contents of total K but relatively small amounts of plant-available K^+. Potassium is found as a component of several minerals that release it to soluble and exchangeable forms by weathering at greatly differing rates. These forms are shown in the adjacent figure. Some of these minerals also have the capacity to reabsorb (fix) added K^+ back into their structures in nonexchangeable form. Even the exchangeable K^+ is bonded with different strengths depending on the type of charge to which it is adsorbed. Thus, the release of K^+ by minerals to soluble and exchangeable forms, and the release to and adsorption from the soil solution by exchange sites are both forward and reverse reactions (reaction seeks equilibrium). The rates of these reactions are regulated by mechanisms that depend on relative strengths for bonding K^+. Any test that adequately reflects the K^+ available to a crop in a growing season must measure that in solution plus that which is available to be released to the soil solution and taken up by the crop during the growing period.



Various studies have shown that 7% or less of the total K requirement of crops is in the immediate vicinity of the roots (Nemeth,1978; Drew and Nye,1969). Also, Barber (1962) noted that on the basis of the water requirement of a given crop, the concentration of K^+ in the solution extracted from most soils is insufficient to meet the K requirement of the crop by the transpiration-imposed mass flow of the soil solution. Therefore, the K requirement of crops must be met by some mechanism that moves additional K^+ from the exchangeable form to the root. The diffusion coefficient for K^+ is relatively low and may not be possible to supply all the needed K by this mechanism. It seems more likely that a combined mechanism involving ionic exchange and mass flow may account for much of the K requirement for a crop, with diffusion making up the remainder.

There are several ways to interpret soil test K values. One is to determine a base level which is adequate for optimum growth of a given crop on a given soil. If the release rate of K is not influenced by soil characteristics then that value would be the same for all soils. This concept is commonly referred to as the sufficiency level of available nutrients (SLAN). A second interpretation would be to establish the percentage of the CEC that the K^+ needs to occupy which would supply the needs of a crop (base cation saturation ratio - BCSR). Using this concept as the CEC of the soil change, the sufficiency level for K would also change.

Most early agronomists used the SLAN approach to interpreting soil K test. In the past 20 to 30 years many researchers have collected data that indicate that the release rate from the exchangeable K pool is not the same for all soils. For some soils the release rate is very high (>5 lbs K^+/acre/day) at relatively low soil test levels and on other soils it is low at relatively high soil test values. When the major difference between two soils is due to the amount of clay in the soil the BCSR concept should be a good predictor of the release rate for K. The optimum soil test values for each of these concepts have been established at approximately 200 lbs K/a for the SLAN whereas the BCSR requires 2 to 5% of the exchangeable cations in the soil to be potassium.

The following example will illustrate these concepts:

Desired Soil Test K Level (DSTK)
SLAN = 200 lbs K/a
BCSR = 2 to 5 % of B.S.

Ex. 1

Silt Loam Soil with a CEC of 11
DSTK - SLAN = 200 lbs/a
DSTK - BCSR = 2 to 5 % of B.S.
2% = 172 lbs/a
3% = 258 lbs/a
4% = 344 lbs/a
5% = 430 lbs/a

A long term K study in Ohio for a Crosby Silt Loam soil indicated that a soil test of about 240 lbs K/a resulted in optimum yields. The CEC of this soil was 11. The SLAN value of 200 lbs/a is reasonably close to the observed optimum. For a soil with a CEC of 11, and a B.S. of 2.8% from K would result in a soil test of 240 lbs/a. Both these approaches would give reasonably good interpretations for this soil.

Ex. 2

Silty Clay Loam Soil with a CEC of 22
DSTK - SLAN = 200 lbs/a
DSTK - BCSR = 2 to 5 % of B.S.
2% = 344 lbs/a
3% = 516 lbs/a
4% = 688 lbs/a
5% = 860 lbs/a

The actual crop response for K on this soil indicated a soil test of 360 lbs/a was optimum. The SLAN interpretation underestimated the needed value whereas the BCSR interpretation of 2.8% over estimated (480 vs 360) the desired soil test K for corn.

In 1975, Fisher suggested the equation DSTK = 220 + 5 * CEC to determine the soil test value which resulted in optimum yields when the changes in the CEC of the soil are primarily due to clay content and not changes in organic matter of the soil. Using this concept, the predicted soil test value for the two examples would be 275 lbs/a for example 1 and 330 lbs/a for example 2. This formula gave better agreement than either of the SLAN or BCSR interpretations for predicting DSTK levels for Ohio soils.

The use of Fisher's hybrid formula which incorporates both the SLAN (220 base level) plus the BCSR (5 * CEC) has limitations.

The soils where this formula works best are:

1. Soils with CEC from 5 to 30.
2. Soils where the CEC change is due primarily due to clay content.

The areas where the formula does not work well is:

1. Sands with CEC below 5.
2. High organic matter soils with CEC greater than 30
3. Soils with excessive calcium (>80% B.S. and pH > 7.5).

References

Barber, S. A. 1962 A diffusion and mass-flow concept of soil nutrient availability. Soil Sci. 93:39-49.

Drew, M. C. and H. P. Nye. 1969. The supply of nutrient ions by diffusions to plant roots in soil: II. The effect of root hairs on the uptake of potassium by roots of rye grass. Plant Soil 31:407-424.

Fisher, T. R. 1975. Some Considerations for interpretation of Soil Test for Phosphorus and Potassium. Missouri Agric. Exp. Stn. Res. Bull. 1007.

Nemeth, K. 1978. Limitations of present soil test interpretations for K and suggestions for modification: A. European experience. p. 97-111. In Potassium in soils and crops. Potash Research Institute of India, New Delhi.

FERTILITY PROJECTS AT OHIO STATE - 1992

DON ECKERT AND JAY W. JOHNSON

1. DEVELOPMENT OF PRESIDEDRESS N SOIL TESTS FOR CORN - Projects are being conducted at Wooster, Hoytville and Springfield to relate concentrations of NO_3^--N in soils in early June to corn yield and to determine whether such relationships can be used to adjust sidedress N applications.

2. MEHLICH III CALIBRATION STUDIES - Projects are being conducted at Hoytville and Springfield to determine the feasibility of using the Mehlich III extractant as a replacement for Bray-1 and NH_4OAc in routine soil analysis in Ohio.

3. UTILIZATION OF COAL ASH/COMPOST MIXTURES AS SOILLESS GROWTH MEDIA - Studies are being conducted to determine whether mixtures of coal ash and yard-waste compost can be used as soilless growth media in ornamental horticulture and turfgrass situations, or as a soil conditioner in stripmine reclamation.

4. BORON EFFECTS ON SOYBEAN YIELD AND GROWTH HABIT - Studies are being conducted at Hoytville and Springfield to assess the effects of soil-applied and foliar-applied boron on soybean yield and branching.

5. ALTERNATIVE AGRICULTURAL PRACTICES - Studies are being conducted at Wooster and Hoytville to assess utilization of manure and legumes as fertilizer sources in low-input production systems.

6. UTILIZATION OF HORSE MANURE AND BEDDING AS A SOIL SUBSTITUTE - Studies are being designed to evaluate the management of horse bedding/manure mixtures to produce growth media for the landscape horticulture industry.

7. EFFECT OF CROP ROTATION ON N RESPONSE FOR CORN - Study being conducted at Springfield to determine the effect of alfalfa, soybeans or corn on the response of corn to added N.

8. HIGH YIELD CORN AND SOYBEANS - Effects of daily N and P applications via subirrigation at Springfield, Ohio.

9. CORN AND SOYBEANS RESPONSE TO ULTRA HIGH FERTILITY - Study conducted near Springfield to determine the P and K levels required when yields are maintained at > 200 and 70 bu/a respectively for corn and soybeans.

10. NITRIFICATION INHIBITORS EFFECT ON N MANAGEMENT FOR CORN - Studies at Hoytville, Wooster, Columbus and Springfield to determine the need for nitrification inhibitors in various forms of N for corn production in Ohio.

11. K AND N INTERACTIONS FOR CORN - Study near Springfield to investigate the influence of various rates of N and K on the efficient uptake and use of each nutrient by corn.

PROCEEDINGS OF THE TWENTY-SECOND
NORTH CENTRAL EXTENSION - INDUSTRY
SOIL FERTILITY CONFERENCE

November 18-19, 1992, Holiday Inn St. Louis Airport

Bridgeton, Missouri

Volume 8

Program Chairman and Editor:

Ray Lamond
Department of Agronomy
Throckmorton Hall
Kansas State University
Manhattan, KS 66506