7. POTASSIUM (K)

Agricultural crops require and use significant amounts of potassium; for example, a 30 ton crop of tomatoes or an 8 ton crop of hay each remove close to 500 Ibs of K_2O from the soil.

Symptoms of potassium deficiency are characteristic for individual crops but often include yellowing and scorching of foliage. Although the evidence is not solid, potassium is felt to increase plant tolerance to disease, improve quality and shelf life of crops and improve red coloring of crops such *as* apples and grapes. Crop load is often directly associated with K deficiency, with prunes and tomatoes showing K deficiency only when heavily cropped.

The exact roles of potassium in plants are not well defined but K is believed to be involved in photosynthesis, carbohydrate and protein metabolism and water relations of plants.

There are 4 general classes of soil potassium:

1. Mineral potassium comprises 90 to 98% of a soil's total K supply. These minerals are very resistant to weathering and release negligible K to crops.

2 Slowly available potassium comprises from 1 to 10% of the total soil K. It is held tightly between clay minerals and is released only slowly to plants.

3. Exchangeable potassium comprises about 1% of the total K but is available to plants.

4. Solution potassium is available to plants but also susceptible to losses from leaching; it represents about 1/2% of the total soil K.

Potassium adsorption by crops is adversely affected by cool soil temperature, compacted or poorly aerated soil and ammonium-N nitrogen. Thus a crop growing on a cool, poorly aerated soil and heavily fertilized with ammonium sulfate would be a candidate for K deficiency.

Potassium-Water Relations

Crops can show deficient K levels in leaves and exhibit incipient symptoms of K deficiency due to drought rather than a shortage of soil K. K levels in plants rise after an irrigation. Keeping a crop well supplied with water can improve K nutrition better than application of K fertilizers.

Soil Analysis for K

Soil analysis is routinely run for K in most areas and many fertilizer recommendations are made on the basis of such analyses. Because of the different forms of K in the soil (see preceding) it is difficult to get a soil extraction that will measure solely the amount of K available to plants. The validity of soil K tests as an index to predict K needs of crops is currently coming under serious questioning. In Iowa, K is recommended for corn even on high K soils; in North Dakota and Montana, K responses have occurred on soils that have tested very high in K. South African scientists are currently re-evaluating soil K tests after concluding that "the conventional soil analyses do not present a reliable indication of the potassium supplying power of soils in all cases." California is now recommending a nitric acid soil extraction for K (to replace an ammonium acetate extraction) which looks promising. Because of the wide variation in soils it will be difficult to get a K test that is good for all soils.

Plant Analysis for K

Plant analysis for K can be a useful tool in diagnosing K problems, but it is not a definitive tool. As indicated previously, plants under stress for water often test low in K; applying potassium in such cases would be unwise.

A Purdue study suggested that the ratio of K between young and old tissue was a better indicator of K status than any absolute value. The study put it this way: "If the mature tissue contains a percentage of K equal or above that of the immature tissue, the K status of the plant is optimum. But if the mature tissue contains a lower percentage K than the immature tissue, the K status is less than optimum." If valid, this would be a good diagnostic tool.

A study on alfalfa indicated that ratios of K to N and P were a better indicator of K status than K levels alone.

Potassium Application

Soil application

Two materials are available for soil K application: Muriate of potash (61% K_2O) and sulfate of potash (51%K_2O).

Sulfate of potash (potassium sulfate) is more expensive than muriate of potash (potassium chloride) in spite of its lower K analysis. Some growers are leery of the chloride in muriate so they pay more for and use the sulfate form. In most cases, muriate is just as safe as sulfate when broadcast; band application should be avoided and the sulfate form should be used, if needed, on crops that are extremely sensitive to chloride such as strawberries and avocados.

If sulfur is also needed to correct a sulfur deficiency, then the sulfate of potash form is

superior.

Soils vary in their potassium fixing capacity. There is generally very little movement of potassium (from the point of application) on heavy textured soils while movement can be significant on coarse textured soils. Calcium displaces potassium on soil exchange sites and the application of gypsum (calcium sulfate) in conjunction with potassium has been shown to give significant downward movement of potassium. Irrigation water that is high in calcium should also give significant downward movement of potassium. On a drip irrigation experiment, potassium sulfate applied directly under the dripper moved down 2½ feet on a soil with a relatively high K fixing capacity. For tree and vine crops, potash fertilizers applied in a concentrated band should move downward significantly on coarse textured soils, esp. if irrigation water is high in calcium. On heavy textured soils, deep placement may be necessary.

If high amounts of potassium are needed for row crops, most or all of the material should be broadcast (and disced in). Once soil levels of K have been built up over the years, the amount of K in a triple mix fertilizer should be sufficient to satisfy the needs of row crops with a high K requirement, such as potatoes. Because of its higher analysis (compared to sulfate of potash), muriate of potash is used in most triple mix fertilizers fertilizer burn (from chloride) can occur when large amounts of such mixes are banded on row crops.

Foliar application

Because soil applications are more economical and provide a greater amount of K, foliar applications of K are not common. When foliar applications are used, potassium nitrate is the material used. Potassium nitrate sprays are frequently used on prune trees in the Sacramento valley of California in those years when very heavy crops induce a K deficiency; such sprays must be repeated at about 2 week intervals to have a continued beneficial effect.

Effects of Excess Potassium

Too much potassium is not directly toxic to plants but can have adverse effects. Over fertilization with potassium can induce a magnesium deficiency. On apples, too much potassium in relation to calcium will increase the severity of bitter pit. Caution should be used when applying potassium; it should be applied only where a need can be shown.

General Reference

Kilmer, V.J. et al, (ed.). **The role of potassium in agriculture.** Amer. Soc. of Agron, Madison Wisconsin. 1968. (Proceedings of a 1968 symposium on K published in book form).