CONSERVATION AGRONOMY TECHNICAL NOTES

U. S. DEPARTMENT OF AGRICULTURE NEW MEXICO SOIL CONSERVATION SERVICE

NOTE NO. 25

January 19, 1973

RE: Plant Food Elements - Potassium

The attached Technical Note on Potassium is the third of a planned series to provide information on plant food elements which are most likely to be deficient in our soils.

If additional copies of this Technical Note are needed for individual references and use in field work, request them from the Plant Science Section.

Attachment

AO
WRTSC, Portland - 2
Adjoining States - 1

POTASSIUM - ABUNDANT OR SCARCE?

In its pure state potassium is highly reactive and dangerous to handle. Therefore, it must be combined with other elements before it can be put into fertilizers or used as food for growing plants.

Many soils in this country have abundant potassium. In general, soils are far richer in potash than in nitrogen or phosphorus. Most soils contain between 0.5 and 2.5 per cent "total" potassium. Many contain from 20,000-50,000 pounds per acre in the surface 6 inches. It has been estimated that the plow layer in our country contains as much potassium as the total known world deposits of water soluble potash salts.

However, even though a soil may have 40,000-50,000 pounds of potassium per acre stored within the plow depth, most of the total potassium is held in minerals and is not available to growing plants.

Soil potassium can be divided into the following four groups:

1. Mineral Potassium - The approximate amounts of potassium contained in the soil in this form ranges from 10,000-50,000 pounds per acre. Mineral potassium is held tightly in feldspars and micas. These minerals are very resistant to weathering and release very little to the growing plant.

2. Difficultly available Potassium - Amounts range from 100 to 1,500 pounds per acre. The potassium in this group is held mainly between layers of clay minerals. When these clay minerals collapse together, potassium ions are trapped and cannot get out.

   The amount of difficultly available potassium has been estimated by boiling the soil in nitric acid. This process releases the potassium held by clay minerals but does not affect the mineral potassium to any appreciable degree.

3. Exchangeable Potassium - exists as a one-valent cation "K". It represents only a small fraction (80-500 pounds per acre) of the total potassium present but it is in a form available to plants. Exchangeable potassium is held by the negative charges of the soil clay and organic matter.

4. Solution Potassium - This usually amounts to about 1-10 pounds per acre. It is the smallest fraction of the soil potassium and is in the soil solution. Solution potassium is also in a form available to growing plants.

POTASSIUM LOSSES

Losses of potassium by leaching occur only if the exchange capacity is very low and/or the salt content of the soil solution is high. High salt contents in solution cause more potassium to be in solution.

In acid soils aluminum tends to push potassium toward the solution form rather than the exchangeable phase. This means that leaching losses of this plant food element are greater in very acid soils.

AVAILABILITY OF SOIL POTASSIUM

The growing plant obtains its potassium by the following three methods:

1. Root Interception - Growing roots contact, intercept and absorb potassium in their path. However, since roots occupy only about 0.5 to 2.0 per cent of the soil volume to plow depth, they can only bump into and intercept this percentage of the available potassium. This usually amounts to only about 3 pounds per acre.

2. Mass Flow - Roots absorb water and cause a flow of the soil solution containing potassium to the root surfaces. With many crops the water absorbed will contain only about 5-10 pounds per acre of potassium.

3. Diffusion - Since neither root interception and mass flow supply the plant root with very much of the required potassium, diffusion must do most of the job of providing potassium for the growing plant.

   Diffusion is a self-sustaining operation. As a root absorbs potassium, it lowers the concentration around the root surface. This creates a gradient along which potassium diffuses or moves to the root.

   Movement by diffusion is a slow process and only those ions within a distance of about one-fourth of an inch are close enough to reach roots by diffusion.

Most soil testing laboratories determine available potassium by removing the exchangeable and solution potassium from the soil and measuring it. Many labs express the results in terms of available potassium per acre. The level of available potassium expressed as pounds per acre is a measure of the concentration gradient that will be created.

Rates of diffusion do not vary greatly in soils of loam and heavier textures. Sandy soils usually have higher rates of diffusion.

When potassium fertilizer is added to the soil much of the potassium is "fixed" by the soil in a form which is not available to plants.

Fixation occurs within the clay minerals and the amount of fixation depends upon the type of minerals in the soil. When potassium occupies the exchange sites within the clay, the layers may collapse and trap it.

When soils are acid, aluminum and iron ions may occupy the exchange sites between the clay layers. These large ions will remain there even after liming the soil and they help prevent the clay layers from collapsing and causing ready fixation of potassium.

SOME FUNCTIONS of POTASSIUM

1. Imparts increased vigor and disease resistance to plants. It promotes stamina and sturdy growth.
2. Helps reduce lodging by producing strong, stiff stalks.
3. Increases the plumpness of grain and seed. Improves the quality of yield.
4. Is essential to the formation and transfer of starches, sugars and oils.
5. Imparts winter hardiness to legumes and other crops.
6. Aids in protein production in plants.
7. Helps develop the root system.

SOME SYMPTOMS of a POTASSIUM-STARVED PLANT

1. A mottling, spotting, streaking or curling of leaves, starting on the lower level.
2. The lower leaves scorched or burned on margins and tips. These dead areas may fall out, leaving ragged edges.

   In corn, grains and grasses, "firing" starts at the tip of the leaf and proceeds down the edge, often leaving the midrib green.
3. A premature loss of leaves and small, knotty, poorly opened bolls on plants like cotton.
4. Plants like corn, falling down before maturity because of poor root development.

5. Slow plant growth.

6. Seed or fruit is often shriveled.

7. The plants resistance to rust and other diseases is often reduced.

SOME PRINCIPAL SOURCES AND AVERAGE COMPOSITION OF POTASSIUM FERTILIZER MATERIALS

Fertilizer Materials	Chemical Formula	Total Nitrogen N%	Available Phosphoric Acid P_2O_5%	Water Soluble Potash K_2O%	Combined Calcium Ca%	Combined Sulfur S%	Equivalent Acidity or Basicity in Pounds of Calcium Carbonate	
							Acid	Base
Nitrate of Soda-Potash	$NaNO_3 \cdot KNO_3$	15	—	14	—	—	—	25
Potassium Chloride	KCL	—	—	62	0.3	—	Neutral	—
Potassium Nitrate	KNO_3	13	—	44	—	—	—	23
Potassium Sulfate	K_2SO_4	—	—	53	—	18	Neutral	—
Sulfate of Potash-Magnesia	$K_2SO_4 2MGSO_4$	—	—	26	1.0	15	Neutral	—

HOW TO FIGURE FERTILIER - POTASSIUM
CONVERSIONS BASED ON CONTAINED POTASSIUM

Potassium (K) in pounds X 1.2046	= Potash (K_2O) in pounds
Potash (K_2O) in pounds X 0.8301	= Potassium (K) in pounds
Potash (K_2O) in pounds X 1.8499	= Sulfate of Potash (K_2SO_4) in pounds
Sulfate of Potash (K_2SO_4) in pounds X 0.5405	= Potash (K_2O)in pounds
Potassium Nitrate (KNO_3) in pounds X 0.4658	= Potash (K_2O) in pounds
Potash (K_2O) in pounds X 2.1466	= Potassium Nitrate (KNO_3) in pounds
Potassium Carbonate (K_2CO_3) in pounds X 0.5658	= Potassium (K) in pounds
Potassium (K) in pounds X 1.7674	= Potassium Carbonate (K_2CO_3) in pounds
Potassium Carbonate (K_2CO_3) in pounds X 0.6816	= Potash (K_2O) in pounds
Potash (K_2O) in pounds X 1.4672	= Potassium Carbonate (K_2CO_3) in pounds
Potassium Sulfate (K_2SO_4) in pounds X 0.4487	= Potassium (K) in pounds
Potassium (K) in pounds X 2.2284	= Potassium Sulfate (K_2SO_4) in pounds
Muriate of Potash (KCL) in pounds X 0.5244	= Potassium (K) in pounds
Potassium (K) in pounds X 1.9068	= Muriate of Potash (KCL) in pounds

RELATIVE POTASSIUM REQUIREMENTS FOR SOME NEW MEXICO CROPS AND PLANTS

Very High Requirements	High Requirements	Medium Requirements	Low Requirements
Asparagus	Alfalfa	Barley	Apples
Beets, early	Beets, late	Beans, Lima or String	Bent Grass
Cabbage, early	Beets, Sugar	Carrots, late	Blackberries
Cauliflower, early	Bermuda Grass	Cherries	Blueberries
Cauliflower, late	Broccoli	Clover, Alsike	Bluegrass, Kentucky
Celery, early	Brome Grass	Clover, Ladino	Deciduous Plants
Celery, late	Brussel Sprouts	Clover, White	Deciduous Shrubs
Lettuce, head	Cabbage, late	Corn, field, grain	Deciduous Trees
Lettuce, leaf	Carrots, early	Corn, sweet, late	Evergreen Plants
Potatoes, early	Clover, Red	Fescue, tall	Evergreen Shrubs
Potatoes, late	Corn, silage	Flowers, Perennials and Bulbs	Evergreen Trees
Radishes	Corn, sweet, early	Grapes	Lawns, Parks and Fairways
Spinach	Cucumbers	Grass, Sudan	Pears
	Egg Plant	Millet	Playing Fields
	Flowers, Annual	Oats	Putting Greens
	Muskmelons	Orchard Grass	Raspberries
	Onions	Parsnips	Rye
	Peas, early	Peaches	Strawberries
	Potatoes, sweet	Peas, field	
	Rhubarb	Pumpkins	
	Sorgham, silage	Sorghum, grain	
	Squash, early	Soybeans	
	Tomatoes, early	Squash, late	
	Tomatoes, late	Timothy	
		Turnips	
		Vetch, hairy	
		Watermelons	
		Wheat	

REFERENCES

"Our Land and Its Care" - National Plant Food Institute - Third Edition, Second Printing-1956

"Potassium in Soils" - Plant Food Review - Final Issue #1, 1969

"Western Fertilizer Handbook" - by the Soil Improvement Committee of the California Fertilizer Association - Fourth Edition, Second Printing-1968

"La Motte Soil Handbook" - Research Department, La Motte Chemical Products Co. - reprinted March, 1971