POTASSIUM 4Growth

Komodo® 0-0-13 and Komodo Pro® 0-0-16

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Potassium and Plant Growth and Productivity

Potassium (K) nutrition and fertilization has received a great deal of attention the agricultural press in the last few years. Many suppliers tout the importance of potassium supply to the plant. More research is devoted to understanding potassium requirements and supply in agricultural crops. Is this just more aggressive marketing? Or is adding potassium really that important? These questions are not just academic or theoretical topics. As yield expectations increase, so does nitrogen inputs increase. When you increase nitrogen, and thus plant growth, you MUST put all other nutrients in balance. That includes potassium. Let's take a closer look at the importance of potassium and put it into perspective.

Necessity of Potassium

A plants mineral content shows the necessity of the nutrient. From basic plant physiological information typically cited from Emmanuel Epstein in 1965, the "average" amount of potassium in plant tissue is established at 1% actual K. This is in relation to nitrogen, which is reported as 1.5% actual N. So, in a sense, for every pound of N required to grow a plant, you need to add about 0.67 pounds of actual K (or 80% K2O from a fertilizer standpoint).

Potassium is not a component of structural substances in the plant but is significant in a variety of other ways. They include the following:

Functions of Potassium

Enzyme Activation – Enzymes are actually non-structural proteins in the plant that catalyze, or make it easier, for reactions to occur in the plant. Without enzymes the daily business a plant cell has to conduct grinds to a halt. Potassium "activates" many key enzymes responsible for plant growth. It does this but causing the enzyme to be in a physical form to do its job. The amount of K that is in the cell is directly proportional to the amount of enzymes that can be activated at any one time and the rate in which the enzymes carry out their function. This does not mean more is better, just that you need the optimum amount of potassium in the cell.

Cell pH control – Potassium helps the cell regulate its internal pH. The internal pH is important to the proper functioning of a wide array of reactions that need to occur on a continual basis, including enzyme activation and function.

Stomatal activity and water use – Stomates are the "pores" though which plants exchange carbon dioxide, oxygen and water vapor with the atmosphere. Proper exchange of gases and water vapor are critical to photosynthesis and respiration, water and nutrient transport and plant cooling. Stomates

open and close by the help of cells called guard cells. Gard cells move potassium in and out to be able to take in water. When potassium moves into a guard cell, water follows it causing the guard cells to become turgid and open the stomates. As water supply decreases the guard cells pump potassium out of the cells causing guard cells to become less turgid, making stomates close. Inadequate K in the plant causes guard cells to become sluggish - slow to respond - Thus allowing the stomates to stay open longer, making the plant lose more water.
Like guard cells, root cells having adequate potassium can better “absorb” water into the plant roots providing for better water availability. Plants deficient in potassium may be less able to absorb water leading to water stress.

Photosynthesis – Photosynthesis is the process that plants use to convert light energy to chemical energy the plant can use to grow. This process occurs in the chloroplasts of cells where carbon dioxide (CO2) and water (H2O) are reacted with the help of light energy to form adenosine triphosphate (ATP). This in turn is used to make sugars, which in turn is used to make proteins and a whole host of other molecules. ATP is the major energy “currency” most living things use to grow. Kind of like a dollar bill. Potassium is critical in this process – Its effect on stomatal opening and closing allowing for gas exchange, pH regulation in the cell and enzyme activation. But also plants use potassium to orient the leaf blades by the input and exit of potassium in leaf petiole cells, to maximize light interception.

Other Important processes - Because of potassium’s effect on enzymes, pH regulation and stabilization and stomatal function, it is then also important for sugar transport, water and nutrient transport, protein synthesis, starch synthesis, cold tolerance (winter survival), stress resistance and disease resistance.

The more practical reasons for potassium’s importance as a nutrient involves:

- Increased root growth
- Better or improved yields
- Maintains plant turgor
- Improved water use and decreased water stress
- Cold tolerance
- Improved disease resistance
- Improved sugar and starch synthesis/production (fruit and grain “fill”)
- Reduces lodging – Better stem strength
- Moderates nitrogen response – Tougher “harder” plants. Firmer fruit.

Now that we know that potassium is important, how is potassium supplied to the plant? First, we need to understand the dynamics of how potassium is supplied and regulated by the soil itself.

Potassium (K) Supply

Potassium is taken up by the plant roots in its ionic form as K^+ . So, potassium must be SOLUBLE, and in the soil solution for plants to take this nutrient up. With this in mind, K is largely present in the soil as a component of plant minerals. This K is unavailable to the plant. K that is “trapped” between layers of clay, if clay is a component of a particular soil, is mostly “fixed” meaning it is very slowly available. This K is also not practically available to the plant in a growing season. Water-soluble K and K that is held on the Cation Exchange Capacity CEC exchange sites (“exchangeable K”) are considered available to the plant. These two sources along with slowly available K are in a dynamic equilibrium, meaning as plants take up water soluble K, more will be provided by the exchangeable K and slowly available K. But this is not as fast as one may think. When crops are rapidly growing, and taking up K, the amount of K in the exchangeable and slowly available K “reservoir” often cannot keep up with the demand. This is the part of the basis why many times a soil analysis will not predict the needs of potassium and often soil tests showing adequate potassium, or even high amounts of potassium, will still show a yield increase with added potassium!

On top of that, as water-soluble K supply is increased by adding K through fertilizers, the exchangeable and slowly available fractions are “loaded back up”. So, all the potassium that is added does not necessarily mean that it will all be available to the plant. You can see that this is not as straight forward as you would like.

<u>What affects the potassium supply to the plant?</u>

Other than the amount of potassium in the soil, and the amount of added potassium as fertilizer, several other things effect potassium uptake.

Moisture. More soil moisture means more potassium in the soil solution. Dry soils will often respond favorably to potassium inputs to the soil or to the plant foliage.

Soil aeration. More air exchange means more oxygen to the plant roots. This means better root growth and respiration / energy. Plants need energy to take up potassium, among other nutrients. So improving the energy conversion in plant roots will improve potassium uptake.

Temperature. Temperature affect chemical reactions. Physiological processes will work faster as temperatures increase to a point. Cold soils will not take up potassium rapidly as well as other nutrients. Why are liquid starter fertilizers often recommended, when temperatures are still cold? Higher concentration of nutrients with those nutrients in solution! Increasing the concentration of nutrients around the plant roots - to a degree - will offset the effect of cold temperatures and help enhance uptake of the nutrients applied.

Soil type. Physical soil components – Clay and organic matter – Demonstrate negative charges on their surfaces. These negative surfaces attract and hold positively charged elements, such as cations. Cations are positively charged ions. This is called Cation Exchange Capacity (CEC) because these physical components can hold or exchange various cations in the soil solution. When potassium is dissolved in water, it is in its ionic form and it is positively charged. With that said, soils having various amounts of clay or organic matter components will demonstrate various levels of cation exchange capacity (CEC). This would mean that the amount of potassium held by the soil will be largely dictated by the soil type. A fine textured soil having a high amount of clay or an organic soil having a high amount of organic matter may be able to hold a large amount of potassium. Conversely, a coarse sandy soil (little clay or organic matter) will hold little potassium.

Soil imbalances. If you tend to apply a large amount of calcium or even magnesium to a soil, these other positively charged ions (cations) will "compete" to be attached to CEC sites and / or to be taken up into the plant. This is not a common problem but it is a fact.

What affects the potassium requirements of the plant?

Potassium supply is one thing but the requirements of the plant is another thing, although closely related. Potassium requirements can be affected by the following:

Genetics. This is almost self-explanatory. Different plant types require differing amounts of potassium. In many cases, notably in the turf and ornamental area, potassium requirements may be significantly different among varieties.

Root growth. Makes sense. More roots, more uptake. If a plant is stressed or compromised in some way making root growth to be lacking, this will limit K uptake.

Nitrogen applications. When you increase nitrogen supply every other nutrient needs to be supplied in balance for that particular crop. Research shows that obtaining maximum yield does not always hinge on increasing the rate of nitrogen supply.

Cultural Practices. In many cases, a grower will rely on nutrient cycling. For example, with permanent crops, a nutrient may be stored over winter and re-mobilized in the spring. In the case of turf, not collecting clippings will recycle nutrients. If you collect clippings you remove those nutrients.

<u>What forms of potassium can be used to supply potassium to a crop?</u>

Various dry granular forms of potassium are used in the industry, they include:

- Potassium chloride (KCl, muriate of potash, 0-0-60 or 0-0-62)
- Potassium sulfate (K_2SO_4, sulfate of potash, 0-0-50)
- Potassium magnesium sulfate (sulpomag, 0-0-22-22Mg)
- Potassium nitrate (KNO3, 13-0-44)
- Potassium monophosphate (KH_2PO_4, MKP, 0-52-34)
- Animal manures (varied amounts of K2O)

Dry potassium fertilizers need to be spread and tilled into the soil or banded to be effective. Potassium can only be taken up if it is in the root zone and dissolved in soil solution and, thus, in the ionic form. There is varied recommendations on the rates and timing of dry/granular potassium applications. However, rate of application is usually based on soil analysis results. Timing of applications typically includes a pre-plant application (broadcast and tilled in) with possibly a second post plant application as a band placed alongside a plant rows.

There are various liquid potassium fertilizers, many of which are dissolved forms of the above fertilizer sources. The benefit of liquid applications includes:

1. Potassium is dissolved in water and in a form that can be readily taken up by plant roots or foliage.
2. Liquids can be applied through the irrigation system or shanked into the soil or dribble or sprayed on the soil surface. Liquids can be applied as a foliar application too. While foliar application is not the preferred mode of supply, it can be beneficial as a corrective application or satisfy peak nutritional needs or when other factors, like plant stress, limits root uptake.
3. Application timing can be more flexible. For example, it becomes easier to prescription apply potassium, such as "spoon feeding". With coarse soils this may be very important. And liquid applications can be made during periods where potassium uptake is less than desired.

<u>Liquid Sources</u>

- Potassium chloride. This source is commonly used and is very soluble in water. Some growers prefer not to use a chloride source.
- Potassium nitrate. This source provides nitrogen in the nitrate form as well as potassium. Some growers prefer not to apply nitrogen along with potassium particularly when growing fruit. May be made by dissolving potassium nitrate or reacting potassium hydroxide with nitric acid.
- Potassium sulfate. This is a source of potassium with sulfate sulfur. Typically, you do not see liquid forms of this source since potassium and sulfate are not very soluble in water.
- Potassium Thiosulfate. This is a potassium fertilizer that supplied both potassium and sulfur but does not have the disadvantages of potassium sulfate. However, it is not recommended for in furrow application nor is it not always recommended for foliar applications especially in warm weather. Sulfur may be supplied by irrigation water.
- Potassium carbonate. Very soluble in water; however, this source will usually demonstrate a very high pH and may not suitable for high pH soils. Some formulations may have adjusted pH.
- Potassium phosphates. May be made by dissolving various potassium phosphate salts or reacting potassium hydroxide with phosphoric acid.
- Potassium acetate. Made by reacting potassium hydroxide or potassium carbonate with acetic acid (vinegar). Has a characteristically high pH. Some products may be pH adjusted. Acetate is a carbon source.
- Potassium citrate. Made by neutralizing potassium hydroxide or carbonate with citric acid. Citric acid is a carbon source for microbes. No negative effect on foliage. No accumulation of counter-ion or addition nitrogen.

It should be clear from the above that the "counter ion" of the source is something that needs to be considered and that inherently makes the sources what they are. When potassium is in solution, there is no distinction among the "form" of potassium although the resulting pH may play a minor role in uptake. Potassium is taken up as K^+ and not in any other form.

Komodo® 0-0-13 and Komodo Pro® 0-0-16

Komodo and Komodo Pro are two potassium fertilizers that are geared toward applying soluble, readily available potassium along with chelated micronutrients and additional carbon.

Komodo is a 0-0-13 fertilizer formulated with a combination of potassium chloride and potassium carbonate. This product is neutralized to a pH of 5.5. This allays any concerns over applying high pH materials, particularly where soil pH levels are already high or where some tank mixing is desired. A small amount of a surfactant is added to the Komodo products to help soil penetration or wettability of plant foliage.

Growers particularly fighting high salinity situations are concerned over the "salt load" of a product. Komodo Pro is formulated with potassium citrate and the pH adjusted to about 6.0 to 6.5. This makes it well suited to apply to a wide range of soil types without concern of increasing soil pH. Further, given that citrate is a carbon source readily used by soil microorganisms, there is no concern over increasing the salt load of the soil. And there should not be any concerns with applying the product as a foliar application either

Komodo Pro supplies about 1.5 pounds of readily available potassium per gallon of product. As is often the case when applying potassium in the liquid form, potassium is readily available for plant uptake if it can be applied with enough water to get into the root zone.

Komodo Pro is formulated to have a pH less than 6.5. Many potassium products are formulated at a high pH level. This contributes to high soil pH when soil applied or to increased phytotoxicity when applied to plant foliage. Formulating this product at a pH below neutral decreases concern over phytotoxicity when applied to plant foliage.

Komodo Pro contains chelated micronutrients. Often when potassium is applied, micronutrients are also desired. Komodo Pro includes all essential micronutrients in chelated form. This means that a grower has all the bases covered when applying Komodo Pro.

This product can be applied to crops requiring additional potassium. Crops often requiring additional potassium include but are not limited to, alfalfa, beans, corn (V10 to R1 growth stage), vegetable, fruit and nut crops.

Turf growers can use this product on greens and tees to help provide potassium without worry about increasing salinity, adding sulfate sulfur or adding additional N. This product is a perfect tool for adding K, controlling growth and also adding carbon to foster microbial activity in the root zone.

For agricultural applications, the rate of use is one (1) to four (4) gallons per acre as a spray and one (1) to six (6) gallons per acre as a soil application. Even though Komodo Pro has a surfactant added, additional surfactant may be desired to adjust wettability.

For turf, use 8 to 64 fluid ounces per 1,000 square feet (SF). Based upon turf requirements and frequency of application. Eight (8) fluid ounces provides 0.1 lb K_2O per 1000 SF with the high rate at 0.8 lbs K2O. Use the low rate for more routine use and higher rate if corrective application is necessary. Ideally, water into turf after application. Soil type and clipping removal will also dictate rate and frequency of application. Use tissue analysis and growth rate to help adjust application schedule.

Ornamental Trees: Spray using 1.0 to 5.0 GPA in 100 gallons of final solution. This equates to a 1% to 5% solution. Use the low rate for sensitive species of trees. Test plants, if possible, before making full scale applications. See agricultural rates for soil applications.

Compatibility of Komodo Pro. Do not mix Komodo Pro in a concentrated form with any other fertilizer. As a general rule, dilute the total volume of the combination with an equal amount of water such that the combination is diluted 50%. For example, if you want to apply 5 gallons of UAN32 with 3 gallons of Komodo Pro per acre, then for each acre to be treated, you would add 8 gallons of water, then 5 gallons of UAN32, then 3 gallons of Komodo Pro.

Using the example above, if 40 acres is to be treated, the following is necessary:

Material	**Rate (GPA)**	**Total needed**
UAN32 (32-0-0)	5	200
Komodo Pro (0-0-16)	3	120
Water	8	320
Total	16	640

When making applications to surface irrigated fields, set a dosing mechanism to add the appropriate amount of total material so that all the 40 acres are uniformly applied. Set dosing such that field is first wet and time the application so that it is more than 50% and less than 90% of the set.

In the same manner, for drip irrigation applications, set the injection after the soil is wet up and before finish to allow lines to be flushed with clear water. That usually translates to about 50% of the set and before 80-90% of the set.

Parting Comments

Potassium is an important aspect in the nutritional management of any crop. Careful attention to supply and methods of application is essential to getting the most out of your crop. Solutions 4Earth products has tools that growers can use to supply potassium to satisfy their crop needs.