Potassium

ESSENTIAL ELEMENTS | THE FERTILIZER INSTITUTE

Potassium (K) is an essential plant macronutrient taken up in large quantities, like nitrogen. In plants, K does not become part of complex organic molecules. It moves as a free ion and performs many functions.

Potassium in Plants

In plants, K is involved in many essential functions. It serves to:

- Regulate water pressure in plant cells, affecting cell extension, gas exchange, and movement of leaves in response to light;
- Activate enzymes that help chemical reactions take place;
- Synthesize proteins;
- Adjust pH within plant cells;
- Increase carbon dioxide fixation during photosynthesis;
- Transport chemical compounds; and
- Balance electrical charges in various parts of cells.

Harvesting crops removes K from the soil. The quantity removed varies with the quantity of biomass and K content of the plant organs harvested **(Table 1)**.

Table 1. Potassium uptake and removal rates for selected crops.

Crop	Yield Level Per A	K_2O uptake	K_2O removal
		--- lb ---	
Alfalfa (DM)	8 tons	400	392
Corn	160 bu	224	40
Corn Silage (67% water)	25 ton	183	183
Cotton	1,500 lb lint	186	57
Grain Sorghum	130 bu	221	35
Potato	500 cwt	590	325
Rice	7,000 lb	171	25
Soybean	60 bu	138	71
Swithgrass (DM)	6 ton	348	348
Wheat, Spring	60 bu	90	20
Wheat, Winter	60 bu	120	17

Note: Note: To convert K_2O to K, multiply by 0.8301
DM = dry matter (0% moisture) basis
For more crops, visit http://ipni.info/nutrientremoval

Plants that are supplied with adequate K are better able to withstand stress, insect damage, and many plant diseases compared with plants low in K.

As plants age, rainfall leaches K from plant leaves, depositing K at the soil surface. Plants therefore redistribute K from lower depths to the soil surface, a process termed “uplift.” Uplift contributes to nutrient stratification in no-till and reduced tillage systems and affects how soil tests change in response to K additions and crop removal.

Potassium in Soils

Plants can only access K when it is dissolved in the soil solution. Contributors to potentially plant-available K are:

- K redistributed from other areas, including: irrigation water, precipitation, commercial fertilizer, manure, biosolids, and sediment deposition;
- Weathering of K-containing primary minerals like micas and some feldspars;
- K released from the interlayers of the layer silicate minerals illite, vermiculite, and smectite; and
- K desorption from surfaces and edges of layer silicate minerals, termed “exchangeable K.”

Exchangeable K is measured by soil tests and is considered readily available for plants. Layer silicate minerals that release K can also “fix” K, or bond K in interlayer positions, thereby removing it from the soil solution. Fixation and release of K by these minerals is dynamic throughout the year.

Fertilizing Soils with Potassium

Potassium minerals are extracted from geologic sources located throughout the world. Impurities are removed from the ore, and the remaining K is transformed into a variety of modern fertilizers. The K content is historically expressed as K_2O, even though fertilizers do not actually contain K_2O.

Right Source

The most commonly used K fertilizer source is potassium chloride (KCl), also referred to as muriate of potash **(Table 2).** Chloride-free sources of K fertilizer are sometimes preferred for applications made to chloride-sensitive crops. Compound fertilizers containing chloride, sulfur, and/or magnesium are appropriate when soil supplies of these other nutrients are limiting. Liquid products or solid products that are highly soluble in water are used for fertigation.

This information was originally developed by the International Plant Nutrition Institute.

Table 2. Commercial sources of potassium fertilizer.

Fertilizer Name	Chemical Formula	Typical nutrient concentration, %				
		N	P_2O_5	K_2O	Mg	S
Monopotassium Phosphate	KH_2PO_4		52	34		
Potassium Chloride (Muriate of Potash)	KCl			60-62		
Potassium Hydroxide Solution	KOH			45		
Potassium Nitrate	KNO_3	13		44		
Potassium Thiosulfate	$K_2S_2O_3$			25		17
Potassium Sulfate (Sulfate of Potash)	K_2SO_4			50		17
Potassium Magnesium Sulfate (Sulfate of Potash Magnesia)	K_2SO_4 2Mg SO_4			22	11	22

Right Rate

Recommended rates of K application are based on both soil testing and crop removal. “Maintenance rates” are those equal to the quantities of K removed and are used to maintain soil fertility.

Right Time

If chloride-sensitive crops are part of a rotation, chloride forms may be applied to non-sensitive crops grown earlier in the rotation, leaving time for chloride to move out of the root zone. For situations when additional nutrients in a compound fertilizer are needed and the forms of those nutrients are mobile in soils, like chloride and sulfate, applications should be made near or during the cropping season.

Right Place

Potassium sources vary widely in their effect on the soil solution (salt index). Potassium fertilizer sources with a lower salt index may be used at higher rates when placed near or in direct contact with seed. Subsurface bands of K can provide benefits over broadcast applications when subsoil fertility is lower and when drier growing conditions exist.

Potassium Deficiency Symptoms

Potassium deficiency slows the growth rate of plants. In corn, for example, K deficiency leads to delayed pollination and maturity. Leaf margins yellow and eventually die, and leaves may not develop fully. The resulting reduction in leaf area reduces crop yields. Stalks are also weakened, increasing the risk of lodging. Plants have a lower resistance to some diseases and to moisture stress. Reduced cell extension shortens internodes, producing stunted plants that may result in greater harvest losses.

Crop Response to Potassium

When soils do not supply adequate K, fertilization has a high chance of providing profitable crop responses. **Table 3** shows that larger, less frequent fertilizer K applications can be just as effective as smaller, annual applications.

Harvest removes different amounts of K for various crops. Replacement of this K is necessary to avoid long-term depletion of soil nutrient reserves. There are many excellent fertilizer materials available for maintaining the K supply for healthy crop growth.

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Potassium-deficient corn.

References

1. Mallarino, A. et al., 1991. J. Prod. Agric. 4:562-466.

Table 3. Corn and soybean responses and agronomic efficiency of ten annual applications of K compared to the residual effects of a high rate of K rate applied by the initiation of the experiment[1].

Fertilizer Rate	Total K applied after 10 years, lb K_2O/A	Cumulative corn response	Cumulative soybean response	Total response	AE, bu/lb K_2O
		---------------- bu/A ------------			
Annual applications of 48 to 72 lb K_2O/A	600	83	28.6	111.6	0.19
Residual effects of 600 lb K_2O/A	600	89	17.6	106.6	0.18

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