Minnesota Commercial Flower Growers Association Bulletin

Serving the Floriculture Industry in the Upper Midwest

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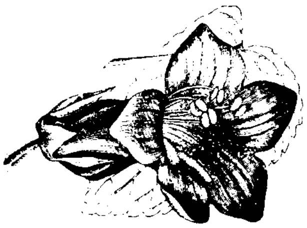

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POTASSIUM

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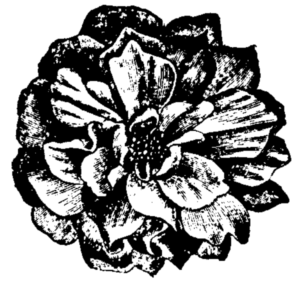
Potassium is a macronutrient vital for plant growth. It is absorbed by plants in larger amounts than any other mineral element except nitrogen. Potassium acts as a catalyst to aid in many of the reactions vital to plant growth. Among the many physiological processes that potassium is involved in are:

1) Cell division.
2) Photosynthesis - formation of carbohydrates.
3) Translocation of sugars.
4) Reduction of nitrates and subsequent protein synthesis.
5) Enzyme activity.

It is also generally accepted that potassium is involved in the carbon dioxide assimilation. Potassium level in plants has a direct impact on the carbohydrate level; potassium deficient plants have a lower carbohydrate level than plants with adequate potassium levels in the media.

Potassium also influences cell wall development. Stem stiffness is related to potassium level in plants. This 'makes sense' because lignin and cellulose development, which are important cell wall components, is directly related to the level of carbohydrate accumulation which, as mentioned above, is associated with potassium level.

Lack of potassium is also related to lodging. Lodging, or falling over, of plants due to stem weakness, is thought to be due to impaired lignification of vascular bundles. Sometimes carbohydrates are used in protein synthesis as rapidly as they are produced. This can happen when nitrate levels are high in the plant. If this occurs, cell walls may be thin and plant stems very weak because potassium uptake cannot keep up with plant demand. This is one of the reasons why the ratio of nitrogen to potassium in the plant is so important. On the tests which we have at the U of M, the nitrogen to potassium ratio should be 3:1.



Potassium is also important in maintaining internal plant pH, allowing the plant to maintain normal growth functions. Even a small shift in normal pH can disrupt normal metabolism (Figure 1).

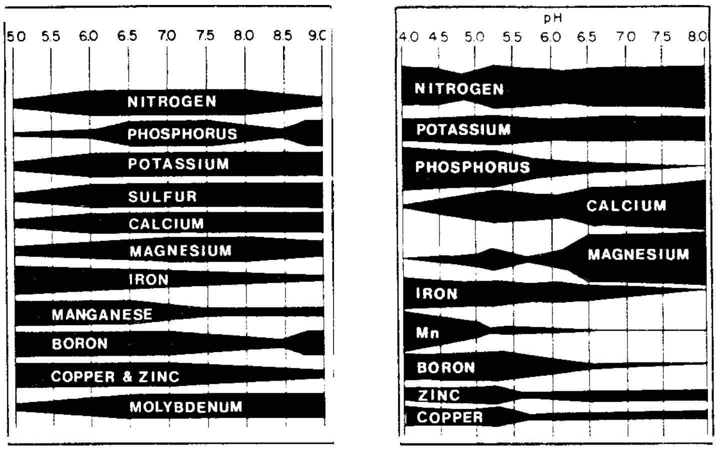
Potassium is characterized as being highly mobile, not only in distance transport via the xylem and phloem, but also within individual cells and tissues.

In general, potassium contributes to the overall vigor of plants.

Plants require varying levels of potassium during different stages of growth.

Potassium deficiency symptoms will show up on the older leaves first.

Figure 1. *The influence of pH on the availability of essential nutrients in (a) a mineral soil (from Truog, 1948), and (b) a soilless root medium containing sphagnum peat moss, composted pine bark, vermiculite, perlite and sand (from Peterson, 1982).*



a b

Potassium is also required for enzyme activation and membrane transport processes. More than 50 enzymes depend partially or completely on potassium for activation. Protein synthesis is reliant on sufficient potassium availability. For example, tobacco plant given sufficient potassium converted three times the nitrogen into protein five hours following a potassium application compared to untreated plants.

Potassium is characterized as being highly mobile, not only in distance transport via the xylem and phloem, but also within individual cells and tissues. Potassium is the most abundant cation in the cytoplasm and potassium salts make a major contribution to the osmotic potential of cells and tissues in many plants. Cell extension, stomatal regulation and other turgor-related processes are related to potassium concentration in plant vacuoles.

Potassium also increases the resistance of some plants to diseases, plants deficient in potassium are generally more susceptible to fungal attack due to changes in enzyme activity and organic compounds present; and improves and helps plants overcome adverse environmental conditions, plants deficient in potassium are generally more susceptible to frost damage. In general, potassium contributes to the overall vigor of plants. It is for this reason that potassium nitrate fertilization is recommended, particularly at the end of a bedding plant production process.

Potassium Requirements of Plants

Plants require varying levels of potassium during different stages of growth. Many seeds contain from 0.1 to 1.0 percent potassium. This level will allow the seed to germinate and grow briefly. As the plants begin to grow they require the addition of potassium to the growing media. Often increasing amounts are needed as the plant continues growth.

There are a variety of potassium fertilizers that are available for use. Depending on other nutrient requirements of plants that you are growing you may select different fertilizers (Table 1).

Plant Growth and Deficiency Symptoms

For most plants, approximately 2-5% of the dry weight of the vegetative parts of the plant should be potassium, for optimal growth.

Potassium is a very mobile element at all levels, as mention previously. Therefore, potassium will move to the growing, or meristematic, regions of the plant. Potassium deficiency symptoms will show up on the older leaves first. Typical symptoms of potassium deficiency are:

- Retardation of growth.
- Chlorosis on the edges of older leaves.
- Necrosis may result, first around the edges and tips of the leaves and eventually moving in toward the midrib.
- If the deficiency is not corrected, younger leaves will show symptoms such as chlorosis.
- A sharp contrast between chlorotic necrosis and healthy green areas of the leaves of many crops.
- In later stages of potassium deficiency and starvation, leaf edges become necrotic, the tissue disintegrates and the leaf presents a ragged appearance. This condition is often called leaf scorch.

Potassium deficiency results in 1) a greater accumulation of soluble carbohydrates, decreased levels of starch and 2) increased amounts of soluble nitrogen compounds. Because of these changes, the activation and effectiveness of many plant processes may be affected.

Both calcium and magnesium compete with potassium for uptake sites on a root. Therefore, if your media contains high levels of calcium or magnesium, you may need to provide more potassium to insure that potassium deficiency will not occur.

Forms of Potassium in Soils

While the total amount of potassium in the soil is usually many times greater than the amount taken up by a plant, generally only a small portion of that potassium is available for plant growth.

Based on degree of availability, soil potassium can be grouped into three categories (Figure 2):

1) Difficultly available.
2) Slowly available.
3) Readily available.

The difficultly available portion is found in the in crystalline structures of primary minerals, such as orthoclase feldspars and muscovite mica. Weathering of these materials causes a gradual decomposition of the material over time. This decomposition brings about the release of potassium that may be:

1) Lost in drainage waters.
2) Taken up by living organisms.
3) Held as an exchangeable ion on surrounding clay particles.
4) Converted to one of the slowly available forms of soil potassium.

Difficultly available potassium is only slightly soluble and makes up 90 to 98 percent of the total soil potassium.

Slowly available potassium comprises about 2 to 10 percent of the total potassium in soils. Slowly available potassium is commonly found in biotite mica and illite.

Readily available potassium makes up about 1 percent of the potassium in soil. It is made up of exchangeable potassium and potassium in the soil solution.

Slowly available potassium and readily available potassium have an equilibrium in the soil. Weak acids and exchangeable cations allow the readily available potassium to be taken up by plants. While slowly available potassium is not readily available to the plants, strong acids can be used to extract it from the soil.

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Readily available potassium makes up about 1 percent of the potassium in soil.

Table 1. *Analysis of representative samples of potash materials. From: Jones, U.S. 1982. Potassium - the catalyst. In:Fertilizers and soil fertility. Reston Publishing, Reston, VA.*

Constituent	Muriate of Potash (KCl) Percent	Potassium Nitrate (KNO_3) Percent	Sulfate of Potash (K_2SO_4) Percent	Sulfate of Potash-Magnesia ($K_2SO_4 \cdot 2MgSO_4$) Percent	Potassium Carbonate (K_2CO_3) Percent
Potash (K_2O)	60-62.5	44-45	50-52	21-22	63-64
Potassium	50.34	36.94	41.34	18.14	52.91
Sodium	1.13		0.76	1.08	
Sulfur	0.11	0.29	17.66	22.73	variables
Magnesium	0.11	0.23	0.70	11.19	variables
Chlorine	47.39	1.14	2.07	1.54	0.42
Nitrogen		12.96			
Moisture	0.21	2.01	0.52	0.30	variables
Other	0.71	46.43	36.95	45.02	46.61
Total	100.00	100.00	100.00	100.00	100.00

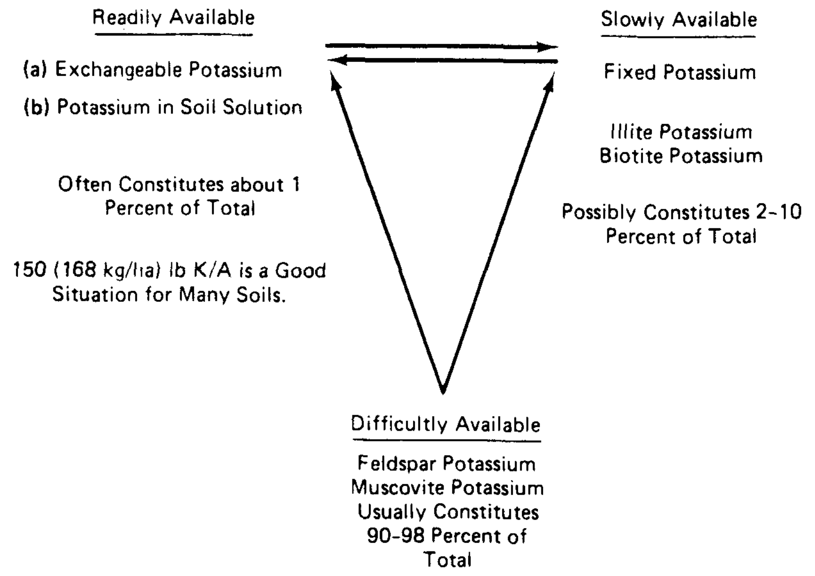

Figure 2. *Three availability categories of potassium in soils. From: Jones, U.S. 1982. Potassium - the catalyst. In:Fertilizers and soil fertility. Reston Publishing, Reston, VA.*

The majority of potassium comes from Canada, the United States, the former Soviet Union, Germany and France.

Due to the vast amounts of potassium in Canada, the majority used in the U.S. is mined there.

In most cases potassium is mined through shaft mining (solid ore recovery), and solution mining.

Where Potassium Fertilizers Come From

The majority of potassium comes from Canada, the United States, the former Soviet Union, Germany and France. Smaller producers of potassium come from Israel, Spain and the Congo.

Large scale mining of potassium was begun in the U.S. in the mid 1910's at Searles Lake, CA. About 10 to 15 year later deposits were found near Carlsbad, New Mexico. Since 1950 further deposits have been found near Moab, Utah and in Saskatchewan, Canada. Due to the vast amounts of potassium in Canada, the majority used in the U.S. is mined there.

In most cases potassium is mined through shaft mining (solid ore recovery), and solution mining. Shaft mining is similar to coal mining, however, new machinery has been developed to reduce the amount of undercutting necessary and directly extracting the potassium ore from the mine face. Solution mining pumps controlled brines into a bed of potassium and dissolved the potassium salts and the solution is then pumped to the surface. This is done where the potassium deposits are found over 5,000 feet below the earths surface.

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DETERGENTS INCREASE THE VASE LIFE OF CUT SUNFLOWERS (*Helianthus annuus* L.)

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Cut sunflowers have become a popular minor cut flower in the U.S., but suffer from poor vase life as the flowers may open poorly and leaves tend to wilt and discolor within 3 to 5 days of harvest. Furthermore, leaf desiccation seems to be accelerated by dry storage and transport so that flowers transported dry for more than 24 hours often have very short vase lives.

In an effort to alleviate this problem, we pulsed cut sunflowers with a non-ionic detergent, Triton X-100. Treatment of cut roses, Chrysanthemum and Gypsophila with non-ionic detergents has proved so successful that a pre-treatment with the detergent Agral LN is not mandatory in the Dutch auction system for these flowers.

In our trials, cut sunflowers were pulsed with solutions containing between 0.01 and 0.10% Triton X-100 for 30,60 or 180 minutes before simulated transport (3 days dry storage at 8C). Longest vase life was achieved with a 1 h pulse with 0.01% Triton X-100. The pre-storage Triton pulse worked in three ways: by increasing solution uptake during the 1 h pulse, minimizing weight loss during the dry storage period, and significantly improving the uptake of water after dry storage, resulting in greater leaf turgidity and longer vase life.

Sunflower could be stored (or transported) at 8C (46F) for up to 7 days after a pulse in Triton X-100 without a significant decline in vase life (Figure 1). It is also possible to keep sunflowers at lower temperatures than 8C. It is not beneficial to place sunflowers in a detergent solution for more than 3 hours, as this results in leaf damage and reduced vase life.

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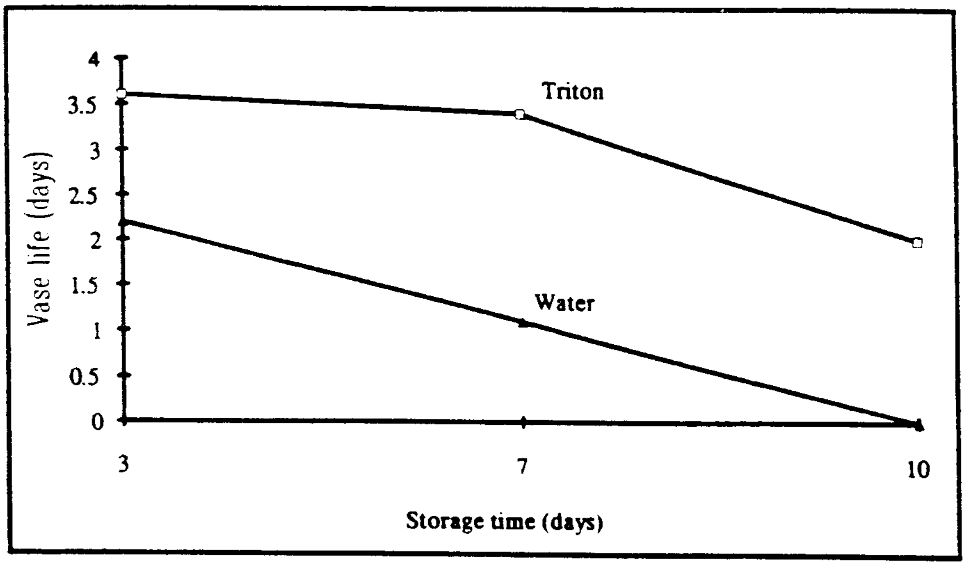

Figure 1. *Changes in vase life of cut sunflowers after dry storage at 8°C (46°F) for 3, 7 or 10 days. Stems were pulsed before storage with : A) distilled water or B) 0.01% Triton X-100.*