13. P-K Symposium 2017

BODEN
ökologie analytik landschaft
TB UNTERFRAUNER GMBH

Geschäftsführer DI Hans Unterfrauner
Rochuspark, Erdbergstraße 10/33, A-1030 Wien
office: +43 676 3641030
mobil: +43 664 3890397
office@bodenoekologie.com
www.bodenoekologie.com

FN 430626z / Gerichtsstand Wien
UID: AT U69409936
Bankverbindung: Erste Bank Oesterreich
IBAN: AT41 2011 1826 6448 0200
BIC: GIBAATWWXXX

Potassium
(Data – Myths - Facts)

Univ.Lek.DI Hans Unterfrauner

General information

Potassium (K) is the **7th most common** element found in the **earth's crust**. Rocks contain an average of 1.9% **K**. This native **K** is mainly bound in feldspars and mica. In the course of weathering and soil formation, this **K** becomes increasingly released, partially washed out and transported into the **oceans**. The "**fertilizer K**" originates from salts that were precipitated in gigantic ocean bays about 250 million years ago and deposited in layers. Large deposits are also found in Germany (e.g. Salzdetfurth, Bokeloh, Werra, Philippsthal, Zielitz, Staßfurt). The world's first **K-mining** operation emerged around **1850 in Staßfurt**. The mining was monopolistically operated by the **Deutsche Kalisyndikat GmbH** (German Potasssium Syndicate Ltd.). It was not until the 1960s that international corporations also began to exploit the **K** deposits worldwide. From this historical point of view, the close connection of industry (K&S GmbH), traders, and farmers to the nutrient **potassium** is relatable.

Potassium cycle

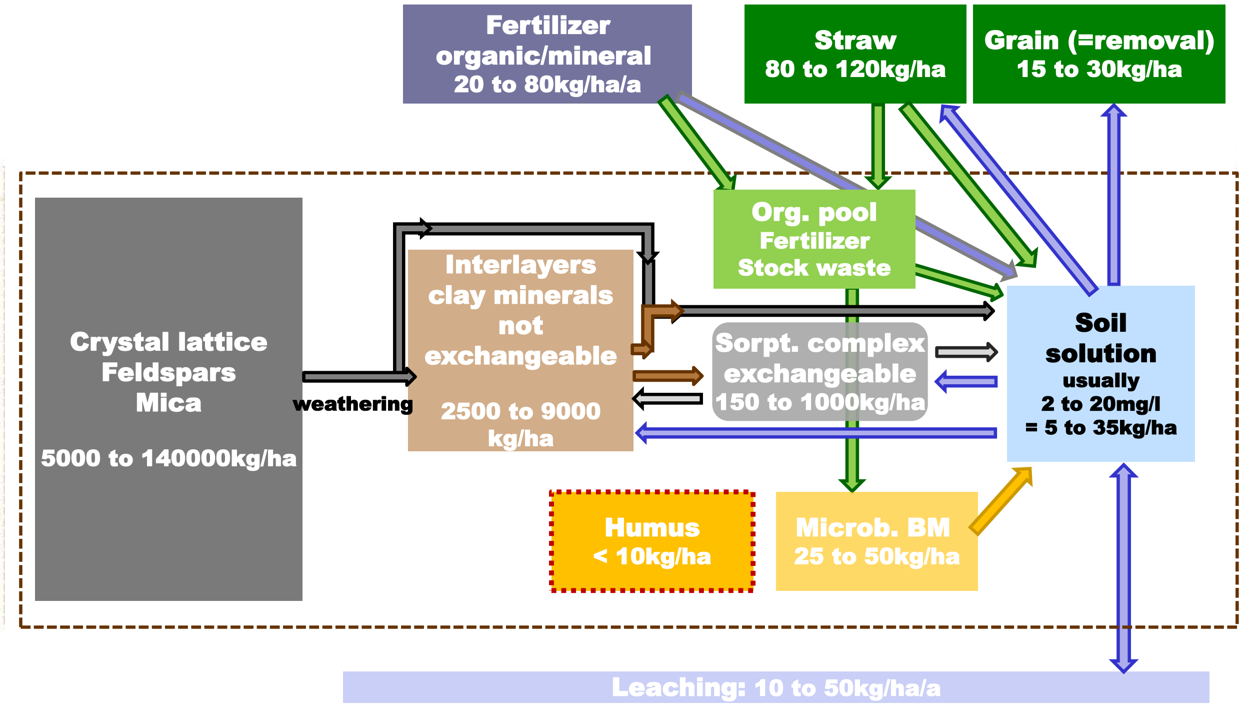

Figure: Potassium cycle

K is found in soil in various **mineral** binding forms (pools). There are dynamic equilibria between the pools, which are connected to each other via the **soil solution**. The transitions take place at different rates. Although K is continuously dissolved from the **crystal lattices** of the rocks by weathering processes, the amounts released annually are small. The K bound in the **interlayers** of clay minerals is mobilized by expansion of the interlayers. **Acidification** and low K concentrations in the soil solution promote this process. **K** at the **sorption complex** is exchangeable and passes **rapidly** into the soil solution.

K in the **soil solution** can be **taken up by plants** or eventually be **leached**. The processes of mobilization are opposed by processes of **fixation**. **Organic K** storage as for P, S and N does not exist, **humus** is de facto **free of K**! However, soil microorganisms contain **K** in their cells, so an active soil makes an important contribution to **K** supply. By supplying mineral/organic fertilizers containing **K**, potassium is introduced into the soil cycle. **Important: the functions of K in the plant decrease with increasing stage of development (maturity). At the time of flowering, K is released by the plant back into the soil through the roots (50 to 150kg/ha).**

Potassium storage in the soil

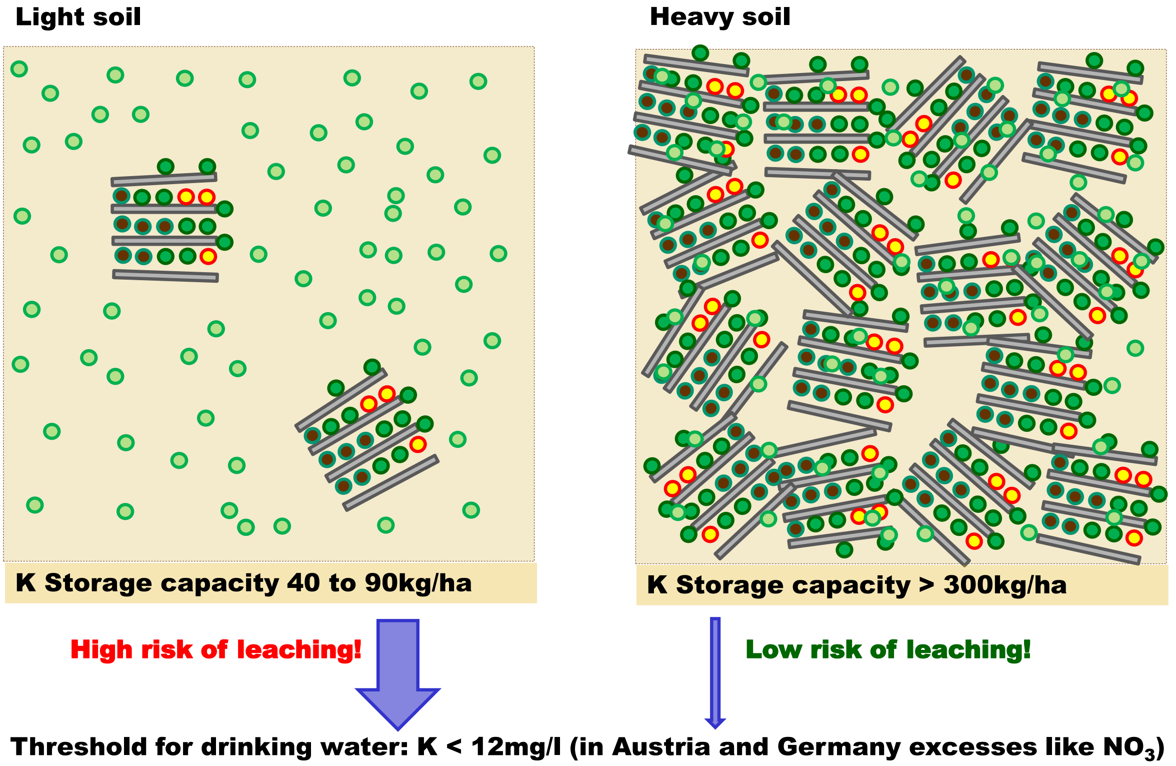

Figure: K storage capacity of light and heavy soils

Sandy, light soils have a very **limited K storage capacity** (40 to 90kg/ha). If a relatively high amount of **K** is fertilized on such sites (e.g. to corn, potato, beet), there is a very high **risk** that part of the K will be **leached** from the topsoil area with the percolating (irrigation) water, **displaced** or fed into the **groundwater body**. The threshold value for **K** (<12mg/l) in drinking water is already exceeded in control wells as regularly as the threshold values for **nitrate**. **Heavy soils** have a very **high storage capacity for K** due to the large number of clay surfaces and intermediate layers, lowering the risk of leaching.

Analysis and assessment of soil K pools

A modern approach is needed to evaluate soil K dynamics. By means of the "**Fractionated Analysis**", different **K**-pools within the ecosystem are recorded. The amounts of **K** of the respective pools are related to each other as well as to the competing cations (especially Ca and Mg) and evaluated. The approach is focused on **"mobilization instead of fertilization."**

Potassium within the plant

K does not enter an organic bonding form, its functions in the plant are tied to the ionic form. Potassium "floats" as a mobile **K^+ ion** in aqueous phases of various parts of the plant and is quite easily translocated.

K fucntions in plants:

- **K** affects the proton pump
- **K** increases internal cell pressure (turgor, cell elongation)
- **K** activates enzymes
- **K** controls water balance

Water balance

Opening and closing of the **stomata** (closing cells) is controlled by **K**. For opening, **K** is displaced from companion cells into the closing cells (> 100,000 atoms/s), turgor pressure increases, the bulging cells open, and water vapor evaporates. This creates negative pressure, which continues as a **transpiration suction** in the form of a continuous water flow from the root zone and the soil solution. For closure, **K** is released back into the companion cells, turgor pressure decreases, and the flaccid cells close the stomata. Other factors in the water balance that are influenced by **K** are **root pressure** and **leaf water potential**.

Favorable K supply optimizes water balance

Sucrose content of sugar beet

There is a close relationship between **N - K** and **sugar content** of beets. Too much **N** causes that CO_2 bound via photosynthesis is not fed into the **carbohydrate metabolism** (= sugar formation), but into the **protein metabolism** (= protein formation). **K** has an osmotic effect, which is why high **K** contents have a negative influence on sugar formation. High **K** contents lead to a high proportion of **soluble ash** and to increased proportions of **harmful nitrogen**.

Excessive additions of K/N reduce sugar content

Starch content of potato

The removal of starch from the leaves into the storage organs is characterized by the **Mg:K** ratio. High **K** contents interfere with the **proton pump** and thus with the transfer of sucrose from the mesophyll of the leaves into the phloem.
TLL studies show a **negative correlation** between **K** and **tuber starch content**. A plot experiment confirmed this negative effect of **K** on starch content of the cultivar 'Möwe' (potato strain). In addition, it was shown that K fertilization had no effect on the tendency to **blackleg**.

Excessive additions of K reduce starch content

Derviation of a STRATEGY for crop production

Target: optimal K supply of the plants through targeted manipulation of the K pools and the dynamic processes in the soil!

- ✓ **Analysis of K pools in the soil**
  - Record pool magnitude
  - Evaluate interactions
  - Derive measures

Fractionated Analysis Unterfrauner

- ✓ **Balancing the actual K removal by harvesting**
  - Cereal/Corn grain: 20 to 25kg/ha
  - Silage corn, potatoes, beet: 90 to 130kg/ha

- ✓ **Keeping K in circulation**
  - Promote replenishment from reserves (pH value)
  - Cover demand (depending on EC stage)
  - Store recirculated K (flowering) in a plant-available form
  - Increase storage capacity

AKRA Karner Düngerproduktion

Consulting/Products

AKRA - Strategy

Control **K replenishment** by optimizing the pH value (pH_{KCl} between 5.9 and 6.9!)

D G C — Dolomite Gypsum Lime

Increase **K storage** by supplying **mineral** substances with a large surface area.

AKRA Kombi

250kg/ha store 12.5kg potassium

K storage in microorganisms

AKRA Stroh R. + P + K