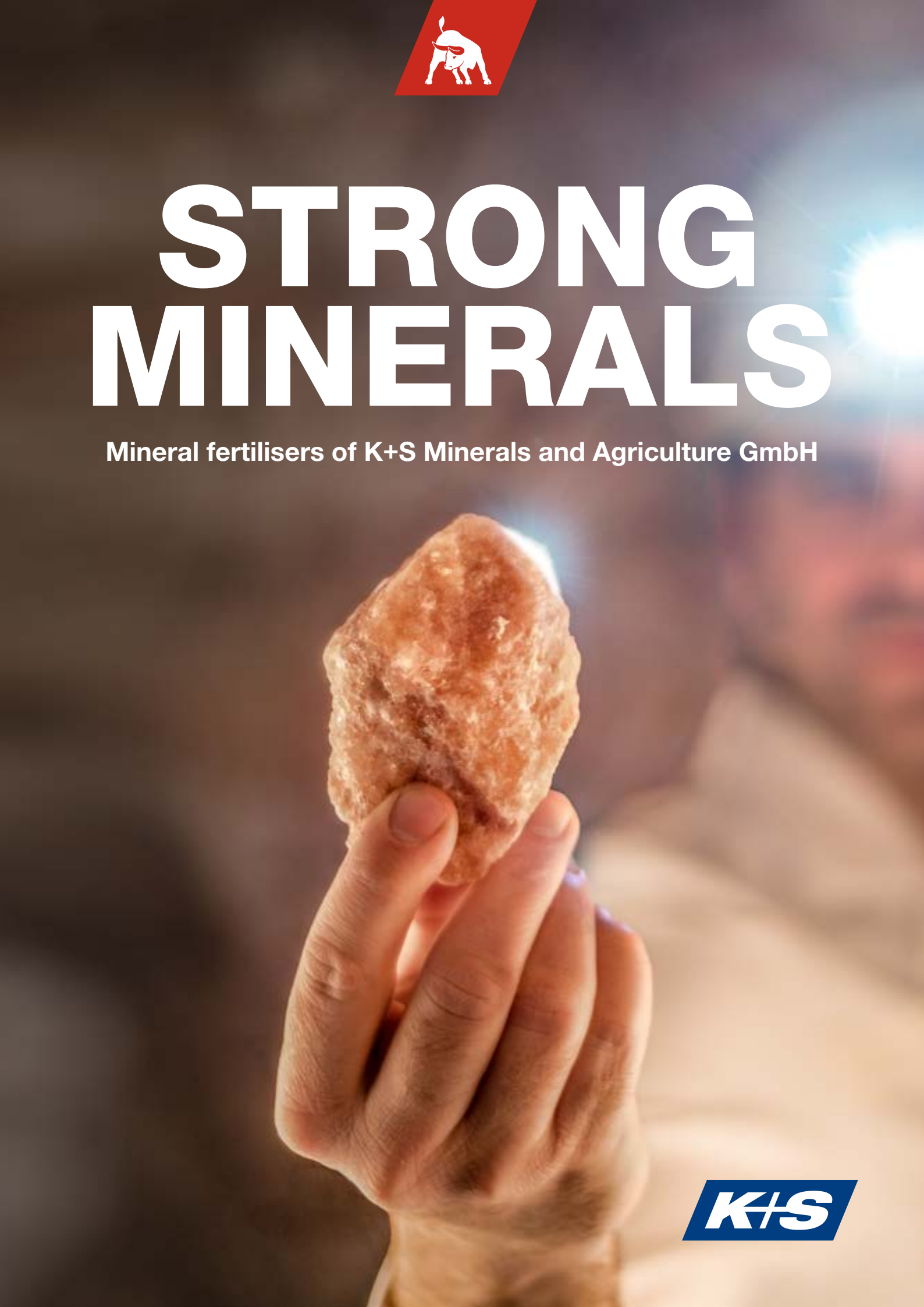
STRONG MINERALS

Mineral fertilisers of K+S Minerals and Agriculture GmbH



THE COMPANY K+S

FROM CRUDE SALT TO HIGH-GRADE PLANT NUTRIENTS

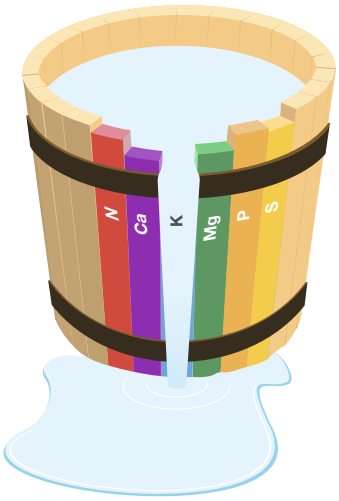
Essential Nutrients –
For Plants, Animals and People

Just a hundred years ago, bad harvests led to malnutrition and famines. For centuries, harvests removed nutrients from the soil that could only be partially replenished by means of natural fertilisers like farmyard manure. There was an open nutrient cycle that led to a continuous decrease in the soil fertility. In addition, a rapidly increasing population could no longer be fed sufficiently. The scientists Carl Sprengel and Justus von Liebig discovered in the first half of the 19th century that it is not the humus but the minerals that are essential for plant nutrition. Besides heat, light, water and air, the plant needs a series of minerals, above all the macro nutrients nitrogen (N), phosphorous (P), potassium (K), calcium (Ca), magnesium (Mg) and sulphur (S). It does not matter for the plant, which source the nutrients come from and if they are applied in organic or mineral form. However, it is decisive that these nutrients are only available to the plants if they are in mineral form. Therefore, organic fertilisers first have to be mineralised in the soil before they can be absorbed. K+S mineral fertilisers contain the nutrients in fully water-soluble and therefore immediately plant-available form.

Liebig's findings coincided with the discovery of potassium salts along with the mining of common salt. Until then, only potassic wood ash was known as a source. Already in ancient times, it was leached in large pots, hence the name "potash". The amounts of potash that were extracted that way were by far not enough to meet the agricultural demand for potash fertilisers. The shortage of potassium was a key cause of the bad harvests throughout the world in the first half of the 19th century.

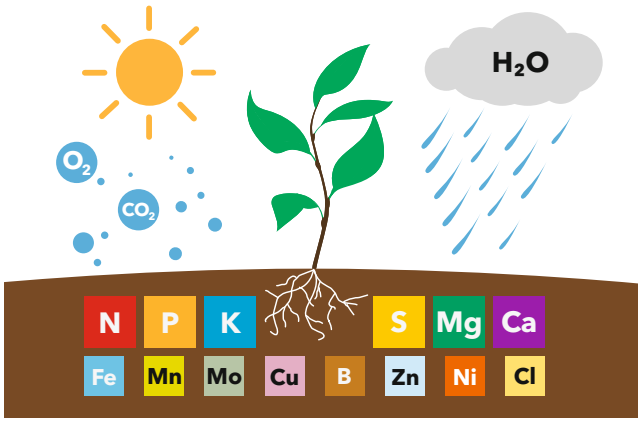
The Romans used potassic wood ash for vineyard fertilisation.

Law of the minimum (Justus von Liebig)



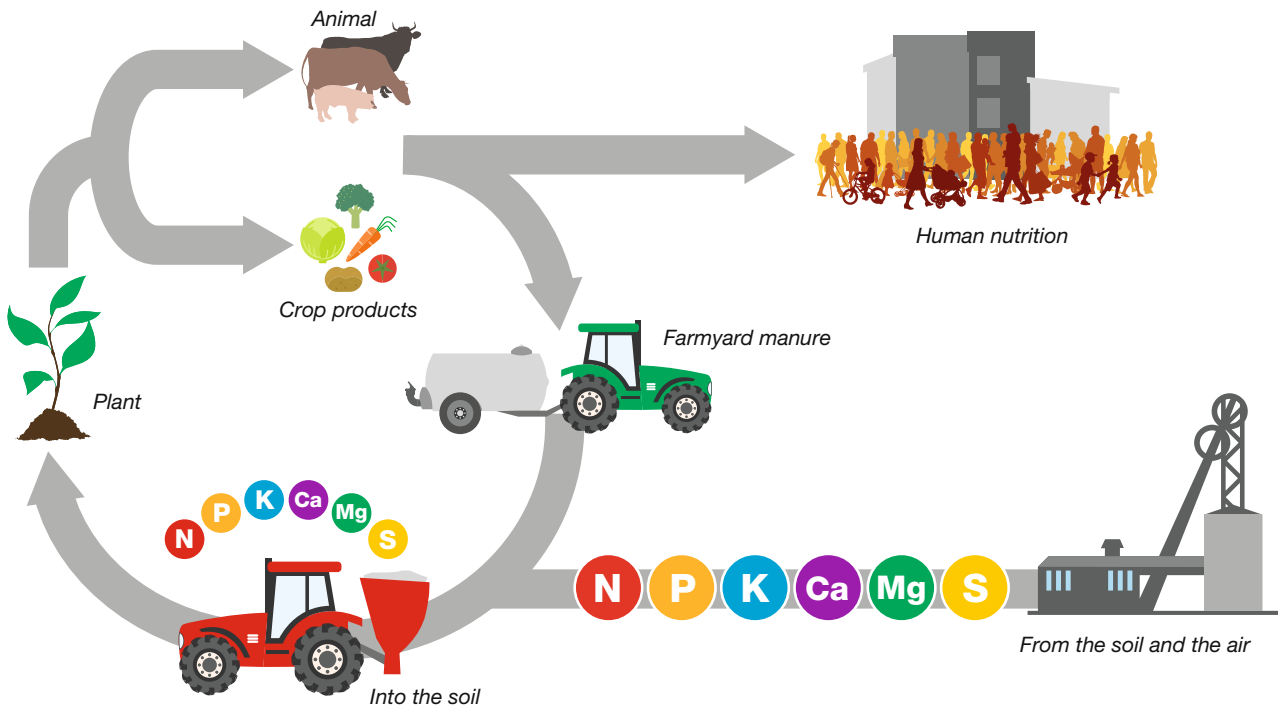
Just like this barrel cannot get completely filled due to the uneven height of the staves, plants cannot bring high yields if a growth factor – for example potassium – is lacking.

What does a plant need to live?



The plant absorbs all essential nutrients in dissolved form from the soil solution, regardless of whether organic or mineral fertiliser was applied.

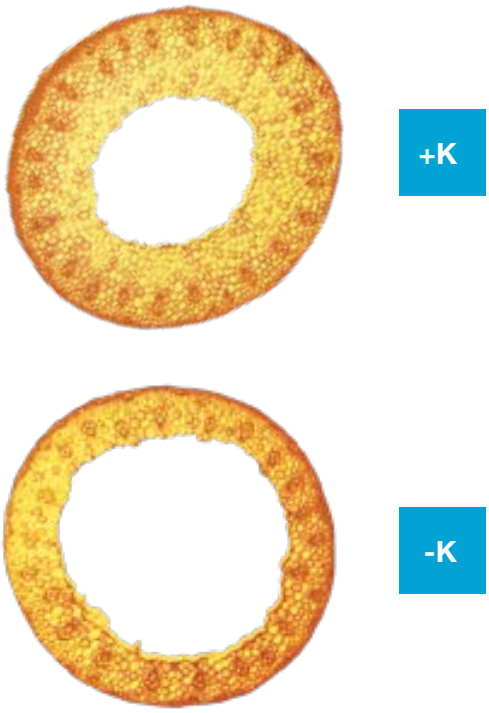
The circle of nutrients



Only mineral fertilisers allowed farmers to close the open nutrient cycle again.

Section of a historic illustration from the beginning of the 20th century. Even then, the indispensability of potassium for plant growth was a well known fact. For example, potassium ensures the transport and the storage of carbohydrates. Furthermore it increases the content of sugar and accelerates ripening.

Potassium for stronger stalks



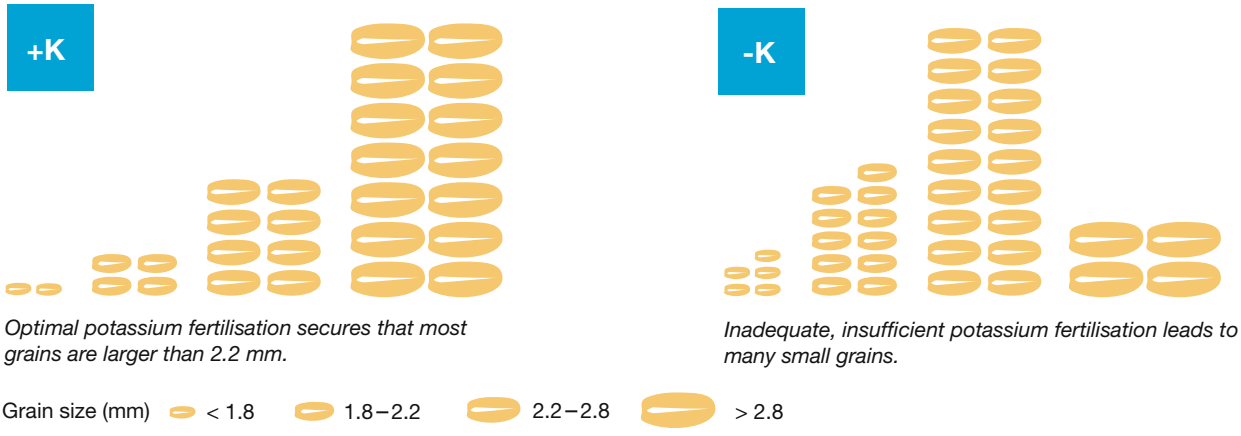
As the cross-sections of grain stalks show, potassium also strengthens the stalk tissue and thereby increases the stability of the grain.

The potash and magnesium minerals that were present in the salt deposits made it possible to solve the nutrient deficiency. Within only a few years, technical processes for the separation of potash from other salts were developed. The mining of potassium and magnesium began in 1861. This was the birth of the potash industry.

Regular mineral fertilisation made it possible to close the nutrient cycle. The fertility of the soil improved significantly in the 19th century. Where one haulm was growing before, ten are growing today. The wheat harvests increased from 0.8 t/ha in the year 1800 to more than 7.5 t/ha today with peak harvests of 12 t/ha.

As a result of a sufficient and balanced nutrient supply, cereal crops for example no longer produce shrivelled but rather fully developed grains, which have the desired protein and starch contents that are needed from the perspective of nutritional physiology as well as for good baking quality. Fruits and vegetables nowadays are not only characterised by a high vitamin and nutrient content but also by an increased shelf and storage life. The sustainable fertility of the soil and high yields with sufficient nutritional quality make it possible that since the time of Liebig, more and more people in the cities are fed by fewer and fewer farmers. For example, one farmer feeds 134 people in Germany today. Within the time of slightly more than one generation, the farmer has increased the number of consumers supplied by him many times (1950 = 10, 2006 = 134).

Grain size distribution from a long-term experiment on luvisol



Optimal potassium fertilisation secures that most grains are larger than 2.2 mm.

Inadequate, insufficient potassium fertilisation leads to many small grains.

A True Success-Story –
The Kali-Producer Germany

In 1856, potash was discovered underground in Staßfurt near Magdeburg in Germany for the first time and mined since 1861.

Until 1918, Germany was the world‘s nearly only potash producer. Today, potash is also extracted in Canada, Russia, Belarus and at the Dead Sea.

The modern potash mines and plants in Germany have a total production capacity of about 10 million tonnes of potash and magnesium fertilisers. More than half is exported to upwards of 70 countries throughout the world. K+S accounts for about 10 % of global potash production.

Kieserite – a valuable component

The German deposits are nearly the only ones in the world that also contain kieserite in addition to the potash salts due to special conditions caused during formation. This makes it possible to extract the important plant nutrients potassium, magnesium and sulphur at the same time and to process them into high-quality mineral fertilisers.

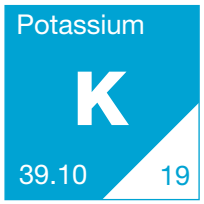
ESTA Kieserit gran. (left) and ESTA Kieserit fine (right) are high-grade magnesium sulphur fertilisers.

Zielitz plant, Lower Saxony

POTASSIUM, MAGNESIUM, SULPHUR AND SODIUM

ESSENTIAL PLANT NUTRIENTS OF NATURAL ORIGIN

Potassium –
Ensures Yield and Quality



The growing plant consists of up to 80 % water. If the dry matter is burned, potassium accounts for the largest content of all minerals at more than 40 %. In particular, young, metabolically active plants are rich in potassium, which can be attributed to its versatile function in the metabolism.

Potassium is crucial for photosynthesis

Numerous enzymes are involved in the photosynthesis or CO_2 assimilation that are activated by potassium. Therefore, the CO_2 assimilation is much higher in leaves with a good potassium supply than in leaves with a poor potassium supply.

Potassium promotes the assimilate transport

The faster the value-determining ingredients (for example sugar, starch) are transported from the leaves to the storage organs, the sooner new substances can be produced in the leaves. This transport depends on a good potassium supply.

Potassium ensures better grain filling

Potassium not only increases the number of grains per spike but also supports the grain formation and thus the thousand-seed weight.

Potassium increases sugar storage

A sufficiently high potassium content in the plant is essential for sugar production in the leaves, transport to the storage organ and sugar storage in the beets.

Improved water use through potassium

When a plant is malnourished, much of the water evaporates unproductively, which means it does not significantly contribute to production of dry matter. The plants regulate the release of water with the help of stomata on the underside of the leaf; a rapid opening and closing of stomata depends on a sufficient potassium supply of the cells in this area.

Improved nitrogen efficiency through potassium

High nitrogen dosages aid the development of green plant parts. An insufficient potassium supply can lead to the formation of loose tissue structure so that the stability of the plant and shelf life of the fruit are negatively affected and the invasion of pathogens is facilitated. This is prevented through good potassium nutrition by means of increased production and storage of cellulose and lignin.

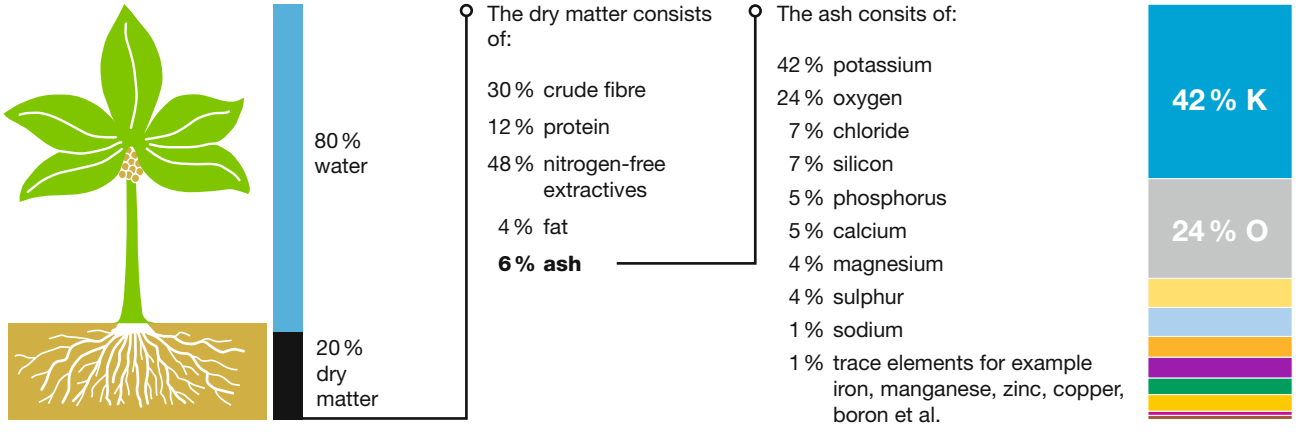
Potassium increases resistance to frost

When a plant receives an adequate amount of potassium, enough substances that lower the freezing point of the cell sap are stored inside the cell. Because potassium supports the formation of strong and dense root systems, there are no serious negative effects if alternating frosts and thaws cause heaving and parts of the roots are torn off.

Potassium increases resistance to diseases and pests

Potassium strengthens cell tissue. Therefore, an invasion is more difficult for fungi and pests.

Average composition of plants



A soil potassium content of only 10 mg K_2O/100 g soil (CAL) inhibited beet growth compared to 25 mg K_2O/100 g soil (right) at the same location and thus reduced sugar production. Korn-Kali with 40 % K_2O as well as its valuable supplementary nutrients MgO (6 %), Na (3 %) and SO_3 (12 %) is the ideal potash fertiliser for performance and quality in the cultivation of sugar beets.

Potassium supply and fertilisation has a direct effect on harvest yield and quality. Disappointing yields are the result of a suspended potassium fertilisation, as the experiment on the left clearly shows (in the front: No potassium fertilised, in the background: potassium fertilised with Korn-Kali).

Magnesium – Essential for Energy Supply and Assimilate Production

Magnesium
Mg
24.31 12

Magnesium is the essential component of chlorophyll. Chlorophyll performs the central function of plant growth, the conversion of the sun's energy into biological/chemical energy. Magnesium plays a key role on the total energy and metabolic performance of the plant.

- Up to 30 % of the total magnesium content of the plant are contained in the chlorophyll. Magnesium is the catalyst for the energy transformation with the help of ATP.
- Magnesium plays an important role in the protein and carbohydrate metabolism. The storage capacity for assimilates in the storage organs (grain, beet, tuber, etc.) is significantly affected by the magnesium content of the plant.
- Magnesium deficiency during the growing phase is directly associated with a reduced photosynthesis rate and thus reduced yield and quality of the plant.
- Magnesium improves root development and enables plants to get sufficient amounts of nutrients from the soil.

Ensuring Sufficient Magnesium Supply

- On soils derived from a parent rock with a low magnesium content, for example loess, granite and shell limestone.
- On light soils poor in humus with low magnesium content.
- On soils low in pH.
- After liming with magnesium-free lime.
- In case of considerable fluctuations in the water status of the soil.
- In case of ammonium-based nitrogen fertilisation, for example ammonium nitrate-urea solution, urea, diammonium phosphate, slurry.

The use of magnesium sulphate ($MgSO_4$) in the form of ESTA Kieserit or in the EPSO products has proven itself in practice.

Magnesium sulphate is completely watersoluble and therefore immediately available to the plant. The solubility of the magnesium products is marked on the packaging.

If the addition "water-soluble" is missing from the marking, then these are magnesium forms that are hardly soluble and will be plant available only to a very limited extent or not at all.

Magnesium deficiency in winter wheat.

Magnesium deficiency in oil seed rape.

Potatoes with optimal potassium and magnesium nutrition.

Sulphur –
Essential for the Metabolism of the Plant

Sulphur
S
32.07 16

Sulphur Fertilisation is Essential

Air pollution control measures have reduced average atmospheric sulphur deposition to only 5–10 kg S/ha/year in Germany and similarly in many other European countries. Therefore, sulphur fertilisation has become a necessary fact in all crops that has to be taken seriously.

In the soil, sulphur can only be stored in soil organic matter. It has to be mineralised first to make the sulphur available to the plant. This leads to the fact that sulphur supply is often insufficient, especially during periods of strong growth or at the beginning of vegetation.

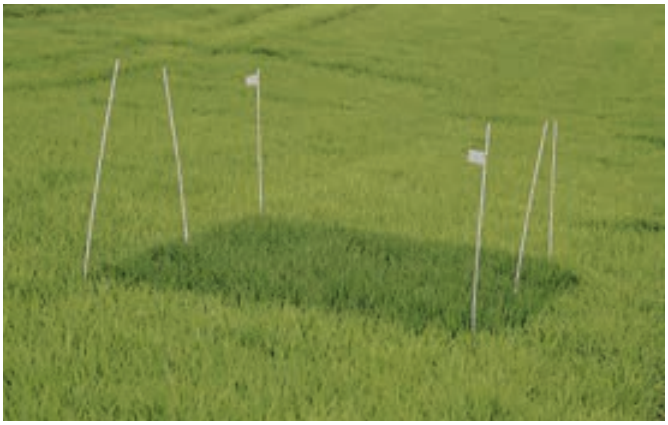
The only solution to have sufficiently sulphur available, is potassium or magnesium sulphate or also ammonium sulphate. All other sulphur fertilisers – generally containing elemental sulphur – have to be converted to sulphate first and therefore need a longer starting time and in addition they are associated with a decrease in soil pH.

K+S offers a series of fertilisers containing sulphur in the form of potassium or magnesium sulphate.

Potassium Sulphate and Magnesium Sulphate

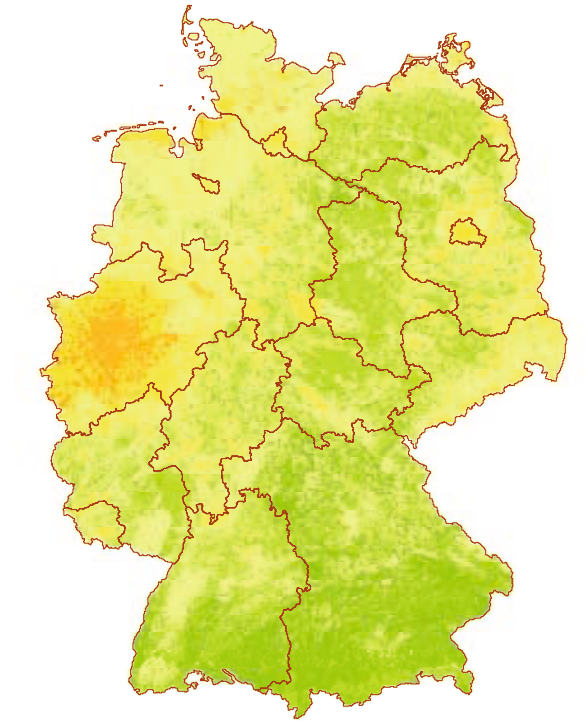
- make a targeted fertilisation possible.
- are fully water-soluble.
- offer the possibility of timely application.
- can be oriented on the need of the plants for sulphur.
- are pH-neutral.

Magnesium sulphate in form of EPSO Top is excellently suited for the use as foliar fertiliser.



Grain field turned green after sulphur fertilisation.

Sulphur Deposition from Rain and Air in Germany (kg S/ha)



In most regions, the sulphur deposit from rain and air is less than the amount that the plants need.

National Focal Center: German Federal Environmental Agency (UBA) BMU/UBA, FE-No. 204 63 252, GIS & Mapping 01/2008: Thomas Gauger

Sulphur deficiency is also provoked by various soil types.

Sulphur

- is absorbed by the plant in amounts similar to magnesium.
- in sulphate form, can be absorbed by the root as well as by the leaf.
- is an essential component for the production of amino acids and thus of protein.
- is involved in the synthesis of sugar, starch, vitamins and flavourings.
- is needed by oil plants for oil production.

Sulphur deficiency – a more and more frequently occurring symptom

In grains:
Low thriftiness, yellowing, rigidity of the plant (easy to mistake for nitrogen deficiency!)

In oil plants:
Marbled leaf surfaces between the leaf veins, red-violet anthocyan production, spoon-like deformations of the leaves, white petals.

In maize:
Young leaves become light green to yellow, low kernel formation at the cob.

Sulphur deficiency in maize

PRODUCTS OF K+S

PLANT NUTRIENTS OF HIGH QUALITY FOR AGRICULTURE

Korn-Kali®

The All-rounder –
Extremely Versatile

Korn-Kali®

EC FERTILISER
Potassium chloride with magnesium 40 (+6+4+12.5)

40 % K_2O	water-soluble potassium oxide
6 % MgO	water-soluble magnesium oxide
4 % Na_2O	water-soluble sodium oxide (= 3 % Na)
12.5 % SO_3	water-soluble sulphur trioxide (= 5 % S)

Korn-Kali®

- is a combined potash and magnesium fertiliser with 40 % K_2O in the form of potassium chloride and 6 % MgO in the form of magnesium sulphate (Kieserite). Further important constituents are 4 % Sodium as sodium chloride (Na_2O) and 12.5 % Sulphur as sulphate (SO_3).
- contains all nutrients in fully water-soluble form. They can therefore be directly absorbed by the plant.
- ensures the basic supply of the crops amongst others during the autumn application with a sulphur content of 5 %.
- has a narrow particle size spectrum ensuring a high spreading quality and enabling a constant distribution at large spreading widths.
- is effective regardless of the soil pH and is therefore suitable for all sites.
- is a valuable partner even in bulk blending.

Korn-Kali increases the sugar-content.

Korn-Kali® has many benefits

Significant amounts of potassium and magnesium are taken from the soil with each harvest. They have to be replenished with adequate fertilisation. Korn-Kali contains both nutrients in a ratio favourable for the plant.

Regularly used in the crop rotation, Korn-Kali meets the specific nutrient requirements of agricultural crops for potassium, magnesium, sulphur and sodium.

Sugar beets are particularly sensitive to potassium deficiency with losses in yield and quality. Korn-Kali promotes the favourable sugar content and the sugar yield even if the soil is adequately supplied with nutrients.

Due to a reduced atmospheric deposition and the use of low-sulphur fertilisers, symptoms of sulphur deficiency can be observed in many regions. The regular use of Korn-Kali forms the basis for the sufficient sulphur nutrition of the plant.

Korn-Kali is the ideal potash fertiliser for stubble and autumn fertilisation and ensures an application in a soil-conserving manner and a good nutrient distribution in the topsoil.

Korn-Kali®: All-round Potassium Fertiliser – Application in Crops

Fields of application for Korn-Kali®

Due to its optimal nutrient composition, Korn-Kali is the most used single-nutrient potash fertiliser in Germany and very common in many other countries of Europe and the world as well. An economic application is possible on all soil types and for almost all crops (plants sensitive to chloride require sulphate-based fertilisers).

Within crop rotation, Korn-Kali should be applied to crops that have high demands on a good potassium supply (for example sugar beets, rape, maize) and that have special requirements regarding specific macronutrients (for example sulphur requirement of rape, magnesium or sodium requirement of sugar beets).

Fertilisation with Korn-Kali is recommended for soils with optimal magnesium contents in order to maintain magnesium levels and to prevent deficiencies (maintenance fertilisation).

Fertilisation with Korn-Kali is especially important for the magnesium supply of the plants, if nitrogen fertilisation occurs in form of amide (urea) or ammonium (for example liquid manure).

Fertilisation recommendations

The amount of Korn-Kali that has to be applied depends on

- the potassium requirement of the crop or the crop rotation,
- the potassium or magnesium supply and dynamic of the soil (site conditions),
- the various requirements of different crops regarding the macronutrients like magnesium, sulphur and sodium,
- the nutrients provided by organic fertilisation.

Autumn fertilisation with Korn-Kali®

Korn-Kali is applied to medium and heavy soils in autumn (stubble fertilisation) and is incorporated into the topsoil layer during tilling. That way, the nutrients are unrestrictedly available at the beginning of the vegetation period.

On light soils, Korn-Kali should be applied in early spring to prevent nutrient loss at these locations.

Korn-Kali is the ideal partner for fertilisation systems with single-nutrient or NP fertilisers and also serves as supplement for the application of compound fertilisers.

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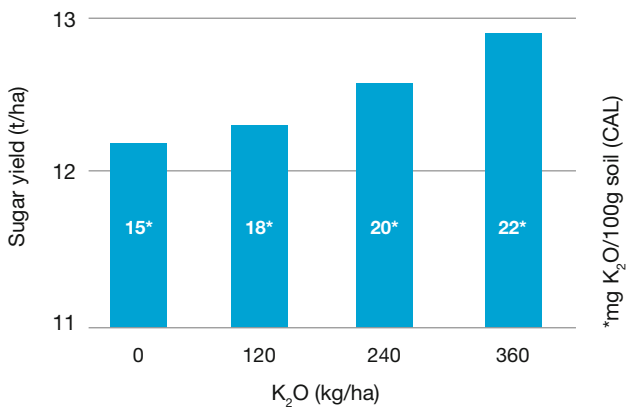
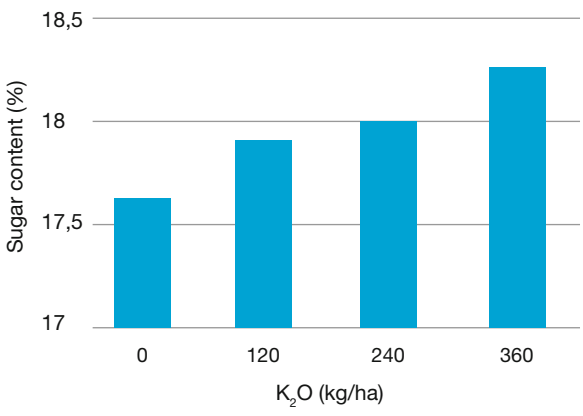
For some crops, the specifications in the table below serve as reference for the fertilisation of soils with medium potassium content, regardless of the organic fertilisation.

Potassium requirement of several crops (in kg K_2O/ha)

Crop	Yield level medium	high
Cereals	100–140	140–180
Oil seed rape	200–240	240–280
Sugar beets	360–400	400–480
Forage/grain maize	200–240	240–280
Forage crops	180–240	240–340

Impact of a different K-supply of sugar beets on sugar yield and content
K+S Minerals and Agriculture GmbH – experiments, 1985–1997





KALISOP®

Premium Quality –
For all Special Crops

FOR ORGANIC FARMING acc. to (EU) 2018/848 (EC) No 889/2008

KALISOP®

EC FERTILISER
Potassium sulphate 50 (+44) gran.

50 % K_2O water-soluble potassium oxide
44% SO_3 water-soluble sulphur trioxide (= 17,6 % S)

KALISOP®

- is a highly concentrated potassium sulphate fertiliser with 50 % K_2O and 44 % SO_3 in sulphate form.
- is water-soluble, so that the nutrients potassium and sulphur are immediately available to the plant.
- is nearly chloride-free and is therefore the ideal potassium source for chloride-sensitive crops.
- has, in compared to other potash fertilisers, a lower salt index and is therefore especially suited for the fertilisation of valuable special crops in intensive cultivation systems.
- is the ideal fertiliser for crops with a high sulphur requirement. Sulphur improves the efficiency of the nitrogen fertilisation and has a positive impact on yield and quality.
- is not hygroscopic and therefore has a good storage stability.
- is certified for organic farming according to the regulations (EU) 2018/848 and (EC) No. 889/2008.

KALISOP® for top quality in the cultivation of fruits, vegetables and tobacco.

The nutrients potassium and sulphur contained in KALISOP are decisive quality-enhancing factors. They play a key role in plant metabolism such as sugar and starch synthesis, protein production, transport of assimilates and activation of enzymes.

Improved appearance and taste

With KALISOP, fruits and vegetables have a more beautiful colouring. Sugar and acid content is increased and aroma intensified. Cash crops thus become more attractive to the consumer.

Increased storage and processing quality

KALISOP increases the firmness of plant tissue in fruits and vegetables, thus improving the storage life and transportability of the harvested products as well as their suitability for processing and preservation.

Top quality in tobacco cultivation

KALISOP improves the external properties like leaf size, specific leaf weight, leaf colour and increases disease resistance. The low chloride content ensures a long burn time in tobacco. In addition, KALISOP enables the optimal adjustment of potassium and nitrogen supplies in combination with singenutrient nitrogen fertilisers.

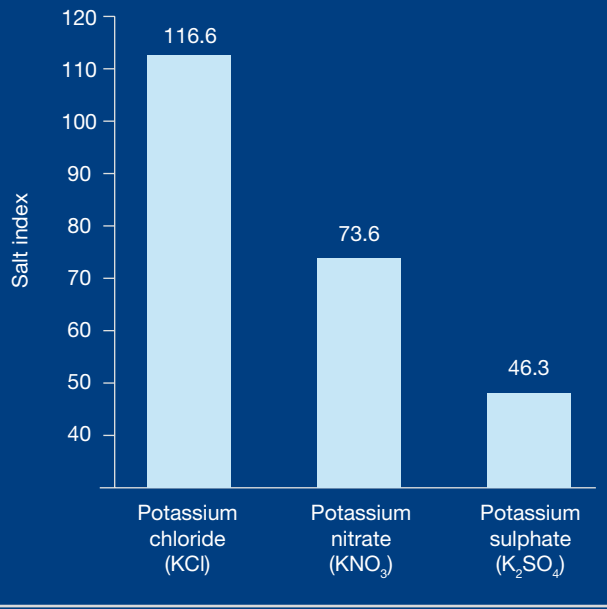
KALISOP® as sulphur fertiliser

- Reduced sulphur emissions from the atmosphere and the continued use of highly concentrated fertilisers with a low sulphur content lead in many regions to a sulphur deficiency in plants.
- Sulphur deficiency causes symptoms, mainly pale leaves, which are very similar to those with nitrogen deficiency. Depending on the nitrogen supply, chlorosis increasingly occurs in older leaves (in case of an inadequate nitrogen supply) or in younger leaves (in case of good nitrogen supply).
- Due to its high sulphur content (44 % SO_3), KALISOP is especially suited for plants with a higher sulphur requirement (oil seed rape, sunflowers, different kinds of cabbage, onions, leeks, etc.). In addition, good sulphur supply increases the utilisation of nitrogen in plants.
- KALISOP contains sulphur in the watersoluble and immediately plant available sulphate form. The soil pH is not altered by KALISOP application.

KALISOP® –
For Crops Sensitive to Chloride and Salt

- Most fruit and vegetable crops are sensitive to chloride and are particularly sensitive to a high chloride supply during germination and early growth. The most important chloridesensitive crops include: Tobacco, soft fruits, stone fruits, grape vines, beans, potatoes, cucumbers, melons, onions, lettuce, early vegetables, greenhouse crops, conifers, flowers and ornamental plants. KALISOP is in principle chloride-free.
- KALISOP has been particularly successful in starch potato cultivation. The assimilate transport from the leaves to the tubers can take place undisturbed, because KALISOP has only a very low chloride content. Therefore, the yield potential of the potato can be fully exploited with concurrent high starch contents.
- The salt concentrations in the soil solution in intensive cultivation systems under glass and in the field can vary depending on the water balance. Growth disorders and lower yields are often the result. Under these conditions, KALISOP is the ideal potash fertiliser due to its low salt index.

Salt index of different potash fertilisers



Potato crisps made from potatoes fertilised without KALISOP: dark spots reduce quality

Potato crisps made from potatoes fertilised with KALISOP: perfect quality

Fertilisation recommendations

- KALISOP enables a precise automatic application with the fertiliser spreader and is also suited for mechanical mixes (bulk blends).
- KALISOP is suitable for basic fertilisation as well as the top dressing of the crops. Potassium sulphate should be applied in spring to soils that are at risk for leaching to prevent losses.
- The optimal fertiliser amount depends on the potassium content in the soil, cultivation intensity and yield expectations. The following recommendations serve as general guidelines for the calculation of the fertilisation of soils with a good potassium supply and medium to high yield expectations. Regional experiences should always be considered when calculating the fertiliser application.

Crop	K_2O (kg/ha)	KALISOP (kg/ha)
Potatoes	100–300	200–400
Oil plants	100–200	200–400
Tobacco	100–200	200–400
Vegetables	100–300	200–600
Tomatoes	150–300	300–600
Paprika	100–150	200–300
Cucumbers/Melons	100–200	200–400
Cabbage	200–400	400–800
Hop	100–150	200–300
Fruit, Soft fruits	150–250	300–500
Vines	50–150	100–300

Patentkali®

The Formula for Success –
For Highest Quality

FOR ORGANIC FARMING acc. to (EU) 2018/848 (EC) No 889/2008

Patentkali®

EC FERTILISER
Potassium sulphate with magnesium 30 (+10+42.5)

30 % K_2O water-soluble potassium oxide
10 % MgO water-soluble magnesium oxide
42.5 % SO_3 water-soluble sulphur trioxide (= 17 % S)

Patentkali®

- is a special potash fertiliser with a high content of magnesium and sulphur. The nutrients are present in the form of sulphate, are water-soluble and therefore immediately available to the plants. In contrast to many other magnesium fertilisers, the magnesium content in Patentkali is 100 % derived from the natural mineral kieserite ($MgSO_4 \times H_2O$).
- is effective regardless of the soil pH and can therefore be used at all locations.
- ensures good spreading quality. The uniform particle size spectrum enables precise distribution even at wide spreading widths.
- is especially suited for plants with a high sulphur requirement (rape, sunflowers, different kinds of cabbage, onions, leeks, etc.) due to its high sulphur content (42.5 % SO_3). A good sulphur supply also improves nitrogen utilisation in plants.
- is certified for organic farming according to the regulations (EU) 2018/848 and (EC) No. 889/2008.

Harvest quality with Patentkali®

- The nutrients potassium, magnesium and sulphur have a significant effect on the quality of the harvested crops. They control important enzyme functions and especially aid protein synthesis and production of carbohydrates and vitamin A.
- The sufficient supply with these nutrients ensures high yields and is at the same time an essential requirement for achieving product qualities fit for the market.
- Drastically reduced sulphur emissions from the atmosphere have already led to sulphur deficiency symptoms in several crops that can only be prevented by relevant sulphur fertilisation. Patentkali with a guaranteed sulphur content of 17 % in immediately plant-available form prevents this deficiency.
- Due to the extremely low chloride content of max. 3 % Cl and the low salt index, Patentkali is especially suitable for the nutrient supply of chloride-sensitive crops in agriculture, horticulture and forestry.

Usage of Patentkali®

- Patentkali is especially suitable for the fertilisation of starch potatoes, potatoes for processing, vegetables, fruits, vines, sunflowers and other special purpose crops.
- The use for processing potatoes and table potatoes leads to improved quality (low blackspot bruising, good storage properties, good taste) and for starch potatoes to an increase in the economically crucial starch yield.
- The quality-enhancing effect of Patenkali is preferably used in the cultivation of fruits and vegetables (many vegetable plants are chloride-sensitive) as well as in viniculture.
- Patenkali is well suitable for the revitalisation of damaged forests with proven K and Mg deficiency.
- The application of Patentkali significantly improves the green colouring of Christmas tree crops and greenery.
- In viniculture to ensure a sufficient potassium and magnesium supply.

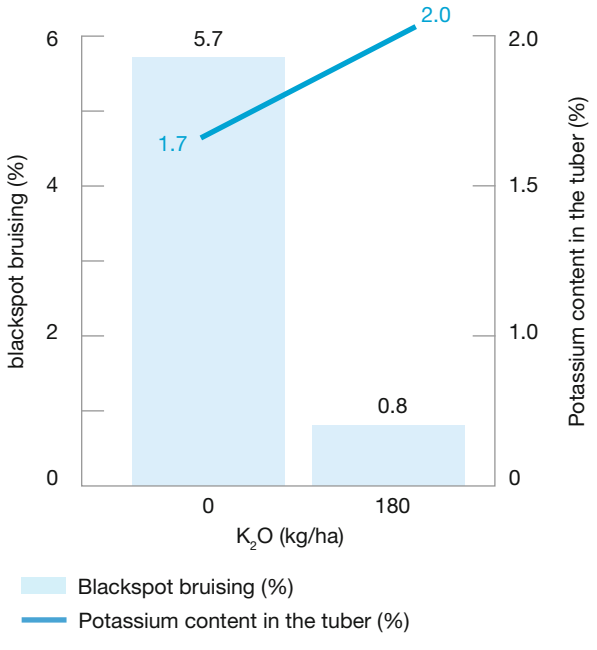
The potassium fertilisation via Patentkali® increases the tuber and starch yield of potatoes.

Potassium fertilisation K_2O (kg/ha)	Tuber yield (t/ha)	Starch yield (t/ha)
0	29.6	6.8
100	41.0	8.4
200	44.5	9.0
300	47.0	9.1

without Patentkali *with Patentkali*

A demand-oriented potassium fertilisation significantly reduces blackspot bruising.

Blackspot bruising drastically decreases with increasing potassium content in the tuber



Time of application

- Patentkali can be applied to all crops until shortly prior to sowing or planting. Top dressing is also possible without any problem.
- On light soils, Patentkali should be applied in spring.

Fertilisation recommendations

The following factors have to be considered when calculating the amount of Patenkali that should be applied:

- the potassium and magnesium requirement of the crop or the crop rotation,
- the potassium and magnesium supply and dynamic of the soil,
- the requirements of different crops regarding the macronutrients (for example magnesium requirement for potatoes, sulphur requirement for different kinds cabbage),
- the amounts of nutrients supplied by organic fertilisation.

The following recommendations serve as general guidelines for the fertilisation of soils with medium potassium contents, not taking organic fertilisation into account.

With Patentkali® the tuber and starch yield of potatoes is much higher because of the nutrients potassium, magnesium and sulphur

Crop	Patentkali (kg/ha)
Potatoes	600–1200
Cabbage and root vegetables	800–1200
Orchards	400–600
Vines	300–400
Soft fruits	600–800
Leafy vegetables	600–800
Forestry	300–500

EPSOTop®

Magnesium & Sulphur – to Close Nutrient Gaps

FOR ORGANIC FARMING acc. to (EU) 2018/848 (EC) No 889/2008

EPSOTop®

EC FERTILISER
Magnesium sulphate 16+32.5

16 % MgO water-soluble magnesium oxide
32.5 % SO_3 water-soluble sulphur trioxide (= 13 % S)

EPSO Top

- is an immediately effective magnesium and sulphur fertiliser for foliar fertilisation. The nutrients are fully water-soluble and are present in sulphate form ($MgSO_4 \times 7\ H_2O$).
- dissolves immediately in water without any residues and is therefore especially suitable for the application as foliar fertiliser via crop protection sprayers or it can be injected into irrigation systems (fertigation).
- can be used as a supplement to soil applications in particular in case of magnesium deficiency and to meet peak requirements. There is no risk of damage to the plant, as long as it is properly used and the recommended concentrations are complied with.
- can be mixed with most plant protection products and liquid fertilisers. However, manufacturer information must be followed.
- is very effective, as it is common for foliar fertilisation, due to the loss-free magnesium and sulphur absorption via the leaf.
- is certified for organic farming according to the regulations (EU) 2018/848 and (EC) No. 889/2008.

Magnesium deficiency in winter wheat

Sulphur deficiency in oil seed rape

Magnesium deficiency in sugar beets

Sulphur deficiency in oil seed rape

Magnesium deficiency in potatoes

Magnesium

- plays an important role in the yield and quality formation of the plants,
- is involved in the efficiency of photosynthesis as the central atom in chlorophyll,
- plays an important role in the energy, protein and carbohydrate metabolism for the growth and storage of assimilates,
- deficiency often occurs during the intensive growth period of the crops. This temporary magnesium deficiency will be quickly and successfully remedied with EPSO Top foliar fertilisation.

Sulphur

- must be increasingly considered in fertilisation, as emissions have been significantly reduced,
- is directly absorbed as sulphate via the leaf,
- is of importance especially for the protein metabolism and increases the nitrogen efficiency during the yield formation.

Kali Fertilizers Pakistan

Your partner for fertigation and foliar fertilizers

KALI
FERTILIZERS PAKISTAN

soluMAP®

Mono Ammonium Phosphate ($NH_4H_2PO_4$)
11.8 % N-NH_4 - ammoniacal nitrogen
61.0 % P_2O_5 - phosphorus pentoxide

Appearance	white crystals
Max Solubility (20°C)	360 g/l water (40% w/v)
Electrical Conductivity (10% sol.)	53.0 mS/cm
Bulk density	1800 g/l
pH in 1% solution	4.2 – 4.8
Chloride as Cl	<0.02%
Water insolubles	≤0.1%
CAS Number	7722-76-1

soluMAP®

- High purity, crystalline NP-fertiliser, suitable for fertigation and foliar application. Low chloride content and low pH.
- Can be used on a wide range of crops and can be applied in all soils.
- **High content of available P and low content of N, in ammoniacal form**, making it ideal for application in the initial crop growth stages.
- NH_4-N in soluMAP® reduces the pH of soil surrounding root system contributing for absorption of native soil P in addition to the fertilizer applied P, resulting in improved P absorption.
- Promotes vegetative growth and root vigour, supports growth of reproductive parts, reduces flower drop, increases fruit setting and contributes to increased crop yield and quality.
- can be mixed with other fertilizers not containing calcium and magnesium.
- soluMAP® in foliar application is an effective and quick way to supply phosphorus and nitrogen whenever a quick response to highly demanding plants is required.
- soluMAP® foliar sprays complement soil applied phosphorous and nitrogen in periods of peak demand for those nutrients.

soluFAMILY

KALI

soluCN®

Calcium Nitrate $Ca(NO_3)_2$
26.5% CaO – calcium oxide
15.5% N – total nitrogen (14.4% $N\text{-}NO_3$ + 1.1% NH_4-N)

Appearance	white granules
Max Solubility (20°C)	1.200 g/l water
Electrical Conductivity (10% sol.)	1.25 mS/cm
Bulk density	1100 g/l
pH in 10% solution	5.7 – 7.0
Chloride	<0.1%
Water Insolubles	<0.1%
CAS Number	10124-37-5

soluCN®

- High purity, fully water-soluble fertilizer for fertigation and foliar application. Only water-soluble source of calcium for high performance crops.
- Provides N and Ca in high concentrations in a readily plant available form
- Low salt index and a relatively neutral pH
- Low in sodium and chlorine content.
- Contains nitrogen in nitrate form, which improves the uptake of calcium and other cations (e.g. Mg and K) from soil
- Quickly replenish the Ca requirement and improve the plant vigor and growth even when Ca availability is reduced due to low plant transpiration.

- Improves bud formation, fruit setting and strengthens plant cell wall, leading to better fruit quality, increased shelf life, pest and disease resistance. Ca is an important component of the cell walls
- Improves the plant resistance to many pests and diseases
- Compatible with other fertilizers and plant-protection products. **Caution** when mixing with **sulphates** and **phosphates**. Perform tank mix before application.
- Constant supply of Ca is essential due to its restrict mobility in the plants.
- Used for controlling disorders such as blossom end rot of tomato, pepper, brinjal, melon, squash; cork spot and bitter pit in apples, internal tip burn in cabbage; hollow heart of brassicas; and black heart of celery

soluFAMILY

KALI

soluSOP®

Potassium Sulphate
50 % K_2O - potassium oxide
17 % S – total sulphur

Appearance	white powder
Max Solubility (20°C)	100 g/l water
Electrical Conductivity (1% sol.)	11.2 mS/cm
Bulk density	1550 – 1750 g/l
pH in 5% solution	1 – 4
Salt index	46
Water Insolubles	<0.1%
Chloride	< 1.5%
CAS Number	7757-79-1

soluSOP®

- Water-soluble fertilizer, source of K and S for fertigation and foliar application
- Virtually free of chloride making it particularly suitable for chloride-sensitive crops.
- Comparatively very low salt index (46) among K sources. Widely used under saline conditions.
- Used when the water available is low in Ca. The presence of high Ca in the water can result in gypsum precipitation in the irrigation lines, clogging the drippers.
- Mixes well with other fertiliser components (except Ca containing products, risk of gypsum precipitate).
- Allows a nitrogen free nutrient solution or flexible potassium – nitrogen ratios during different plant physiological growth stages (e.g. ripening, maturity) when no or low nitrogen supply is required.
- Foliar application of soluSOP® safeguards the nutrient supply during periods of temporary reduced nutrient uptake from the soil, e.g. – nutrient deficiency induced by drought.
- Potassium supply to the plant via the soil-rootsystem can be temporarily insufficient for optimum growth during critical growth stages, e.g. at flowering or during intensive fruit growth. During these growth stages a foliar application of soluSOP® is suitable to cure and prevent potassium and sulphur deficiencies.
- soluSOP® can easily be applied alone or in combination with other fertilisers and plant protection sprays.
- It is not recommended to apply soluSOP® at high air temperatures and when humidity is low.

soluFAMILY

KALI

soluAMS®

Ammonium Sulphate
21 % NH_4-N - ammoniacal nitrogen
23 % S – total sulphur

Appearance	White crystals
Max Solubility (20°C)	750 g/l water
Electrical Conductivity (1% sol.)	65.2 mS/cm
Bulk density	950 – 1100 g/l
pH in 10% solution	4 – 5
Salt index	68
Water Insolubles	<0.1%
CAS Number	7783-20-2

soluAMS®

- High purity, fully soluble, nitrogen and sulphur source for fertigation and foliar application.
- **Low salt index** and moderately low pH.
- Acidifying effect, very **suitable for soils with neutral to alkali** pH levels where soil acidification stimulates the uptake of phosphorus and micronutrients (e.g. Fe, Mn and Zn)
- Is rapidly adsorbed by the plants with least energy consumption and enhance leaf growth, biomass production and tree crown development.
- It avoids leaf chlorosis during peak growth stages and increases tolerance to abiotic stress.

- Foliar applications at concentration 0.5 to 3.0 % are usually recommended
- Compatible with other fertilizers, except Ca-containing products.
- Not sensitive to caking, easy to handle.
- Improves cell elongation and contributes to the production of proteins, supporting enzymatic reactions to improve vegetative growth.

soluFAMILY

KALI

soluUP®

Urea Phosphate

17% N - total nitrogen (0.5% $N\text{-}NO_3$ + 4.2% NH_4-N + 10.3% $N\text{-}NH_2$)

44% P_2O_5 - phosphorus pentoxide

Appearance	white crystals
Max Solubility (20°C)	kg /l water
Electrical Conductivity (1% sol.)	32.5 mS/cm
Bulk density	1.335 kg/l
pH in 1.7% solution	1.8
Water Insolubles	<0.1%
Chloride	<0.1%
CAS Number	4401-74-5

soluFAMILY

KALI

soluUP®

- Fully water-soluble fertilizer suitable for fertigation and foliar application.
- Provides N and P in a directly plant-available form very suitable for the initial and mid-season growth stages.
- Virtually free of chloride (< 1% Cl)
- Acidifying effect contributes to improve micronutrient availability in pH neutral to alkaline soils, keeps pipes and drippers clean; prevents clogging.
- Caution required when mixing with calcium and magnesium fertilizers. Please perform tank mix test before using and follow producer instructions.

soluFAMILY

KALI