



# ESTA® KIESERIT – WITH NATURAL POWER FOR MORE SUCCESS





## Unique – in every respect.

100 % water-soluble. 100 % plant available.

100 % for your yield.

**You would like to constantly increase your yields and secure the long-term success of your business? You consider high nutrient efficiency and the use of natural products in fertilisers to be particularly important? Then, decide to use ESTA Kieserit and utilise the unique benefits our outstanding product offers your fields.**

The usage of ESTA Kieserit as fertiliser saves time, money and exploits the entire yield potential. This is because the fully water-soluble EC fertiliser is the perfect natural source of magnesium and sulphur for every crop. This combination pays off: Through balanced fertilisation with ESTA Kieserit you improve the quality of your harvest products, optimise nutrient efficiency, e.g. for nitrogen, phosphorus, etc., and close any nutrient gaps. In this way you sustainably increase your harvest success.

The excellent ESTA Kieserit characteristics – such as rapid and sustainable plant availability – gives you the chance to use it for many applications in agriculture, horticulture or for special crops and forestry. At the same time, ESTA Kieserit can be used flexibly throughout the whole year, whereby it also protects your plants from frost and heat damage.

### What is ESTA® Kieserit?

Our mineral fertiliser is predominantly made up of water-soluble magnesium sulphate. It is pH-neutral, and therefore does not acidify the soil. The nutrients magnesium and sulphur, present in the magnesium sulphate, are immediately plant available and highly effective.

The base material of ESTA Kieserit is the natural magnesium-rich mineral kieserite, which is extracted during underground mining of sylvinit. After mining, the kieserite is separated from the NaCl residues using “electrostatic separation” – a patented, environmentally friendly, dry separation process. The ESTA Kieserit obtained in this way can be used directly as a fertiliser on your field.

### Completely water-soluble and immediately plant available

You know: The effectiveness of magnesium fertilisers is highly dependent on their water solubility and the resulting availability. The magnesium from ESTA Kieserit is 100 % water-soluble and immediately plant available. Thus, when compared with alternative, non-water-soluble fertilisers, it is highly efficient and especially fast acting and effective.

Thanks to the 100 % immediately available nutrients, you can quickly and easily cover the magnesium and sulphur requirement of your crops even during high demand periods.

### Differentiated by synthetic competitors

In addition to our natural ESTA Kieserit, there are also chemically manufactured products available on the market. However, these are less suitable for use in agriculture as they have a lower nutrient content and are only partly water-soluble.

Unlike our natural ESTA Kieserit, heavy metals and other undesirable components can be found in the synthetically manufactured products. And this will have a negative impact – quality, soil fertility and yield.

Trust the natural original. Choose ESTA Kieserit and secure the long-term success of your farming business.



## ESTA® Kieserit

### EC FERTILISER Kieserite 25+50

25 % MgO water-soluble magnesium oxide  
50 % SO<sub>3</sub> water-soluble sulphur trioxide (= 20 % S)





© rapool

### ESTA® Kieserit – unique in form and efficacy

The magnesium from ESTA Kieserit is extremely efficient due to its solubility in water. A visible magnesium deficiency can be adjusted in a few days after using a fertiliser covering the plant's requirements.

### Application recommendation for a soil with an average magnesium supply

Crop	Yield potential t/ha	ESTA Kieserit kg/ha
Cereals	5–7	100–150
Oilseed rape	3–4	100–200
Maize	8–10	200–300
Sugar beet	50–60	300–400
Potato	30–40	100–150
Pome fruits	Depending on yield	200–300
Vegetables	Depending on yield	100–250

ESTA Kieserit – from naturally occurring magnesium sulphate, fully water-soluble. The fertiliser is classified as suitable for use in organic farming (NE/150/2011) according to IUNG.

- ✓ Fully plant available nutrients
- ✓ Flexible application – all season and for all crops
- ✓ Approved for organic farming
- ✓ Quality 'Made in Germany'
- ✓ Improves the nutrient and nitrogen efficiency
- ✓ Secures yield and yield stability
- ✓ Contributes to the long-term farming success



# Flexible – at any time. Can always be applied. For a fast and sustainable effect.

Whether spring, summer, autumn or winter – there is always a lot of work to do, whatever the season. And precisely when there is a much work do, it would be precious to have more time. With ESTA Kieserit we give you more flexibility. Because our highly concentrated, fully water-soluble magnesium and sulphur fertiliser is not only super effective, it is also super flexible.

Could we reduce your workload if you could already apply fertiliser from late January – early February even on frost? No problem. With ESTA Kieserit you can adjust the individual time of application – when it fits to your needs and those of the plants.

### Application flexibility

If you decide to use ESTA Kieserit, you always make the right decision. Because with our N-free magnesium and sulphur fertiliser you can fertilise sandy soils in autumn and just as easily in spring. At the same time, the weather conditions, which can be problematic for other fertilisers, have no impact on the application and effects of our product. Especially an application on frozen soil in early spring is easy and possible with our ESTA Kieserit.

The huge flexibility brings with it an important advantage: You can reduce the peaks in your work load as much as possible by using ESTA Kieserit. As a natural product certified for organic farming, unlimited use of ESTA Kieserit is also permitted in ground water protected areas.



In this field trial, the effect of magnesium and sulphur fertilisation is already visible to the naked eye: The fertilised plots show a healthy green.

### Solubility of magnesium-containing minerals in water at 20 °C

Mineral	Chemical formula	Solubility g/l end volume
Kieserite	$MgSO_4 \cdot H_2O$	342 <sup>A</sup>
Dolomite*	$CaMg(CO_3)_2$	0,01 <sup>C</sup>
Magnesite*	$MgCO_3$	0,017 <sup>D</sup>
Magnesium-hydroxide	$Mg(OH)_2$	0,009 <sup>B</sup>
Magnesium-oxide	$MgO$	0,006 <sup>A</sup>

*Magnesium sulphate demonstrated the highest solubility among the different magnesium compounds. For this reason, kieserite shows good plant availability.*

Source: A: Taschenbuch für Chemiker und Physiker 1949; B: UEIC 2012 \*calculated using solubility products: C: Helgeson et al. 1969; D: Bénézeth et al. 2011

### Suitable for sandy and low pH soils.

Many farmland especially sandy soil and low pH soils, are naturally low in magnesium. Particularly under these conditions, the solubility of our ESTA Kieserit, which is independent of the soil pH-value, guarantees the perfect magnesium supply to your plants.

The sharp decline in the sulphur input from the air and the continuing use of concentrated fertilisers with a low proportion of sulphur leads to the plants receiving too little sulphur in many regions. But you can compensate this – with ESTA Kieserit. Our unique magnesium and sulphur fertiliser contains 20 % sulphur in order to reduce the deficit in your crops. Furthermore, with a sufficient sulphur supply you improve the utilisation of nitrogen by your plants. This makes your fertiliser usage highly efficient.





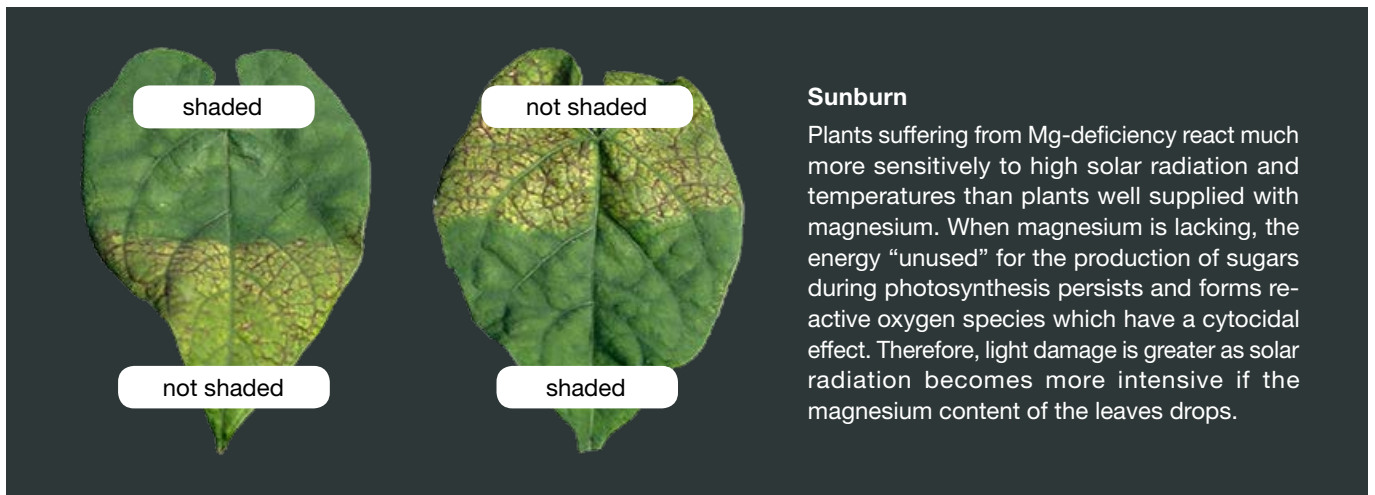




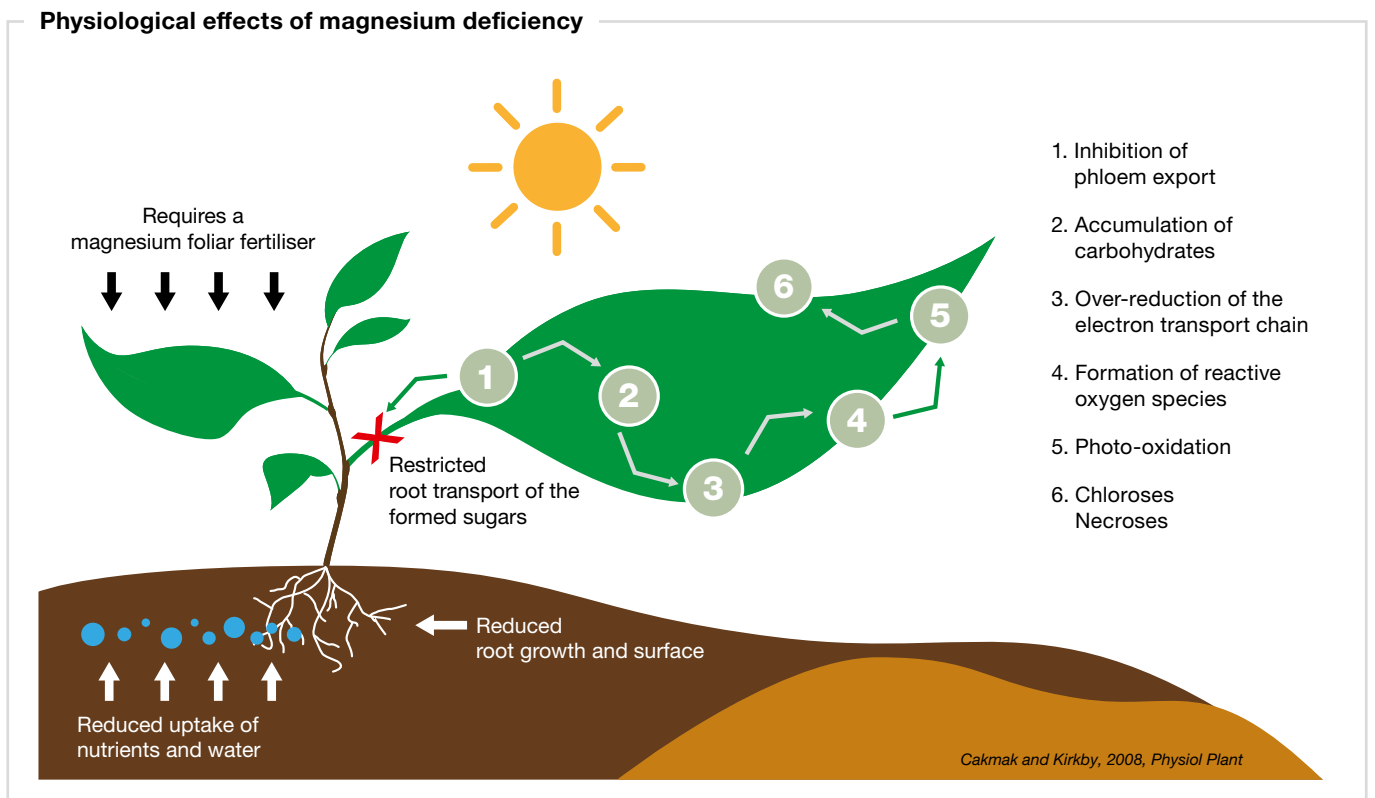
# Protection – for your crops. More stability and reliability. For your yield.

Many factors can have a negative impact on your yield. The weather, for example, plays a decisive role. Extremes of weather, such as dry periods, are increasing due to climate change, and the frosts in winter can also damage the crops. Under these circumstances our ESTA Kieserit provides a lot of

benefits. ESTA Kieserit protects your crops from intermittent frosts and death from cold as well as heat stress and sunburn, and thereby helps to increase yield stability. You want to minimise the risk of yield losses? Then strengthen your plants with ESTA Kieserit – for strong crops and an excellent yield.



Magnesium deficiency makes leaves more sensitive to solar radiation

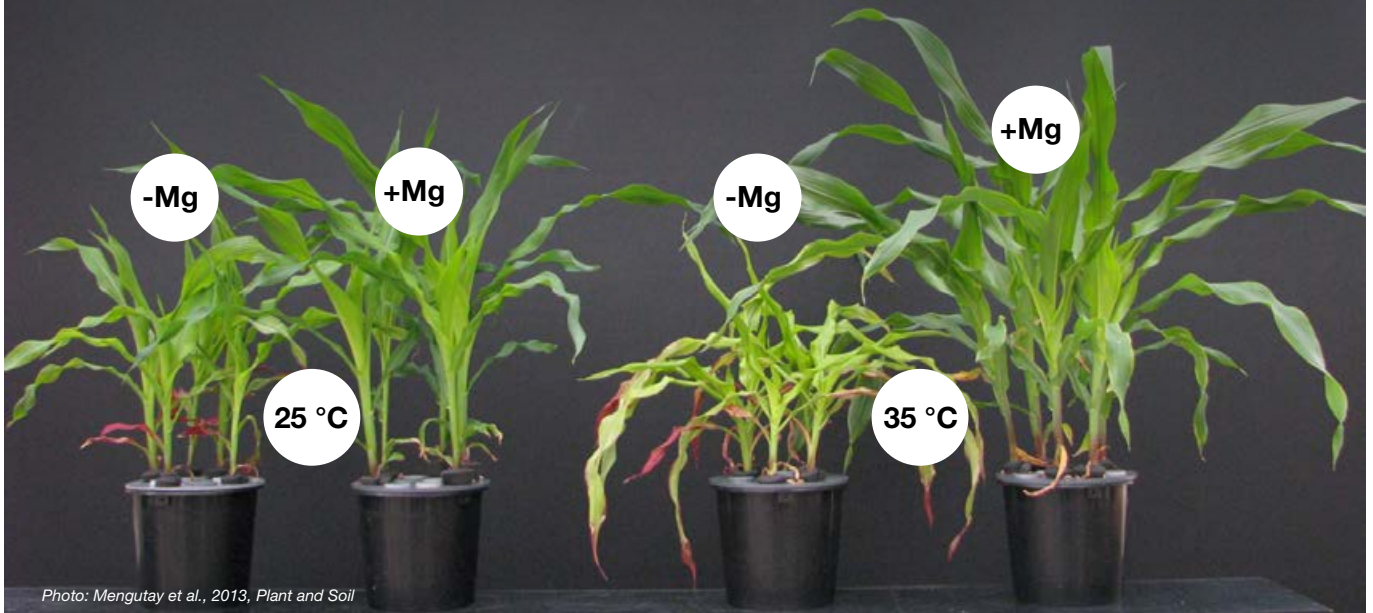


## Heat stress

Magnesium deficiency leads to impaired growth of the entire plant. This effect is intensified by heat. In the process, the root growth is greatly inhibited on the one hand, and shoot growth is reduced on the other hand. A Mg-deficient, heat stressed situation leads to restricted uptake and transport of nutrients

as well as to less water uptake which leads to losses in yield.

With ESTA Kieserit you promote and support the stress tolerance of your plants, so you can improve your yield stability.



## Root growth

Root growth is affected considerably earlier by magnesium deficiency than shoot growth. Reduced root growth can be very difficult to recognise in the field.

Our ESTA Kieserit promotes root length and root mass of your plants by improving nutrient and water uptake from the lower soil levels.

This eases your work as soon as another dry period begins. Thanks to ESTA Kieserit, you can achieve stable and high yields even in dry phases. Fluctuations in yield are no longer an issue with ESTA Kieserit.



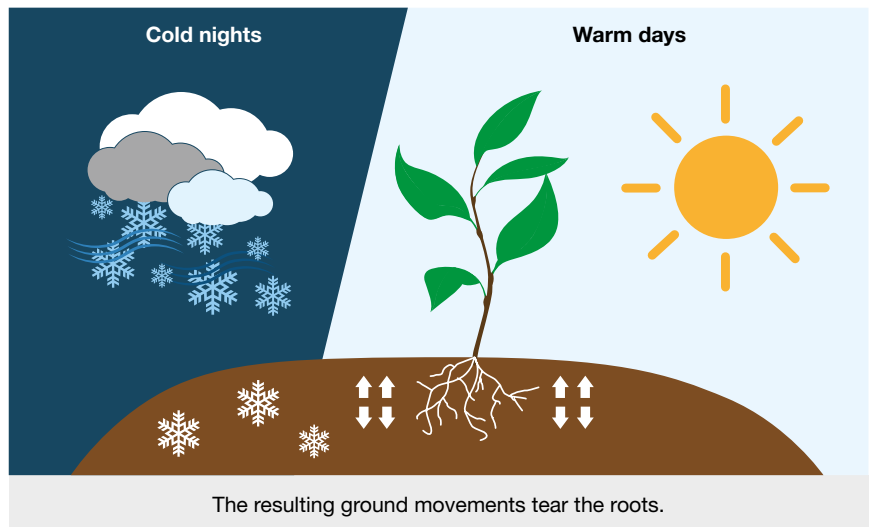
Photo: Cakmak



## Intermittent frosts are a tension test for roots

### Cold stress

Intermittent frosts cause soil shifting – a tensile strength test for the roots. A magnesium supply at the required amount leads to a strong root network that resists damage better. This leads to a better and improved yield stability.



### Effects of magnesium on the harvested parts

Magnesium is of major significance in yield creation, and is essential for many plant functions, not just the formation of chlorophyll. In practice, the lack of magnesium not only has an effect on the yield when the magnesium content of the soil is low. Magnesium is also important during dry periods, for balanced fertilisation and uptake antagonisms. Through the process of photosynthesis, the plants produce sugar from water with the aid of chlorophyll to trap the light energy. Sugar is one of the most important basic building blocks. It is not only an energy source, but is also processed to other carbohydrates such as starch or cellulose. Once again, magnesium as an enzyme activator is required to transport these compounds within the plants, e.g. for root formation or grain filling.

With ESTA Kieserit, fertilised plants show optimum grain filling and yield creation.



*Magnesium deficiency in maize negatively impacts grain filling (left), whereas ESTA Kieserit leads to high yields.*





# Impact of magnesium and sulphur on yield and quality.

Beginning with flowering, magnesium is translocated from the green plant organs (mainly flag leaf and spelt) into the grain. Here, magnesium is essentially needed for grain filling with assimilates and as reserve for the seedling. A foliar

application of magnesium to the flag leaf helps to prevent deficiencies caused by translocation to the storage organs and thus prolongs photosynthesis output until maturation. This results in high thousand grain weights.

## Grain filling of wheat at different levels of magnesium



Seeds from low Mg plants



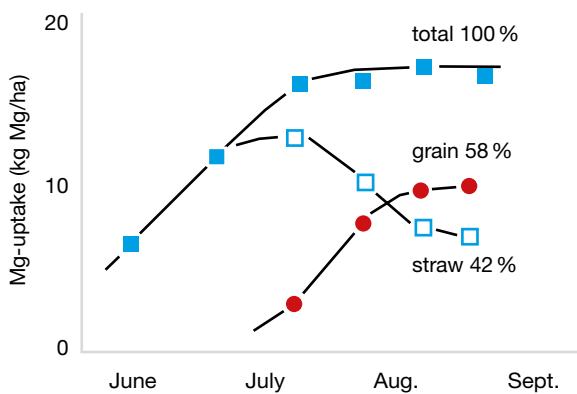
EPSTop  
Seeds from low Mg plants + foliar  $MgSO_4 \cdot 7H_2O$  spray



ESTA Kieserit  
Seeds from Mg adequate plants

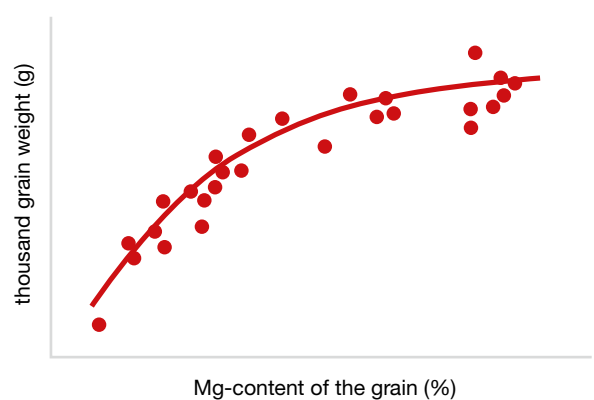
Photos: Ceylan et al., 2016, Plant and Soil

## Mg uptake of plants



Mg uptake into grain and straw of winter wheat during the period from appearance of the second node to harvest: Mg is crucial for grain filling.

Source: Grimme, 1987



Relation between Mg content of the grain and thousand grain weight.



# Supports you – where you need it.

## For optimal nutrient efficiency.

## For better and improved N-efficiency.

### Law of the Minimum (Justus von Liebig)

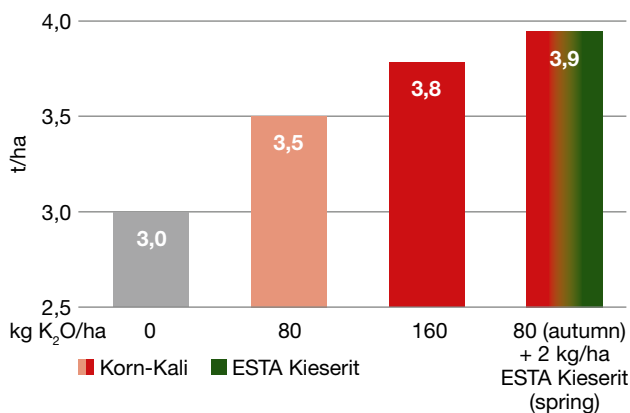
With the new European fertiliser legislation stricter limitations apply to the surplus balances for nitrogen and phosphate. The aim must be to have a balanced amount of fertiliser and a fertiliser system which is appropriate to crop and yield. By doing so with ESTA Kieserit, the nutrient gaps are closed and the yield potential is better exploited. At the same time, this reduces nitrogen and phosphate surpluses.



Like this barrel which cannot be filled due to the irregular lengths of the staves, the plants also cannot deliver a full yield if there is a deficiency in one of the growth factors – for example magnesium.

### Field trials with ESTA® Kieserit confirm the high effectiveness on yield and quality

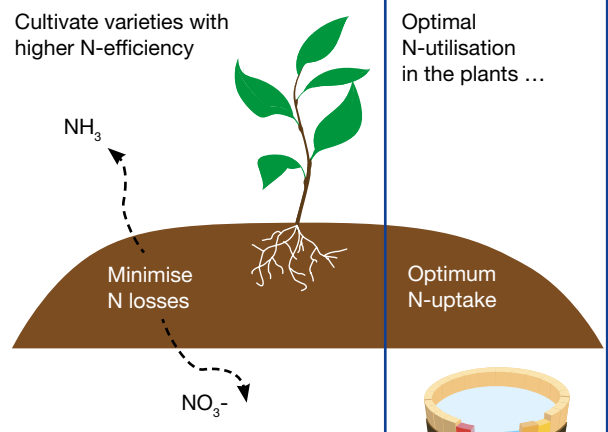
Grain yield of winter oilseed rape depending on the time and extent of fertilisation with ESTA Kieserit (Müncheberg 2014)



The highest yield with winter oil seed rape is achieved with a combined Korn-Kali fertilisation in autumn and an ESTA Kieserit application in spring. ESTA Kieserit improves the efficiency of other nutrients – in this trial the total amount of Korn-Kali could be reduced by a combination of Korn-Kali and ESTA Kieserit in spring.

### How can the N-efficiency be raised in view of the legal maximum levels?

Cultivate varieties with higher N-efficiency



... prevents other nutrients from becoming limiting factors.



Balanced fertilisation with K, Mg and S





**Combined drilling and band fertilisation trials with ESTA® Kieserit**

**K+S field trials from 4 years at 14 sites**

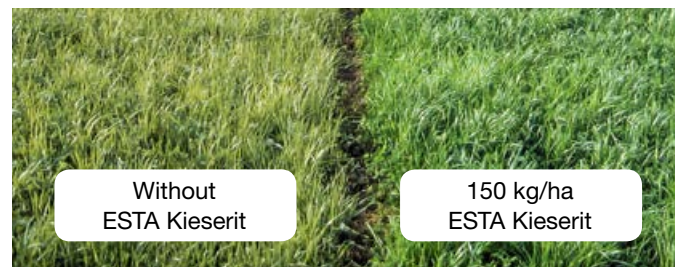
Customary fertilisation	plus 200–400 kg/ha ESTA Kieserit
100 %	108 %

**Standard fertilisation procedure with ESTA® Kieserit in (biogas) maize:**

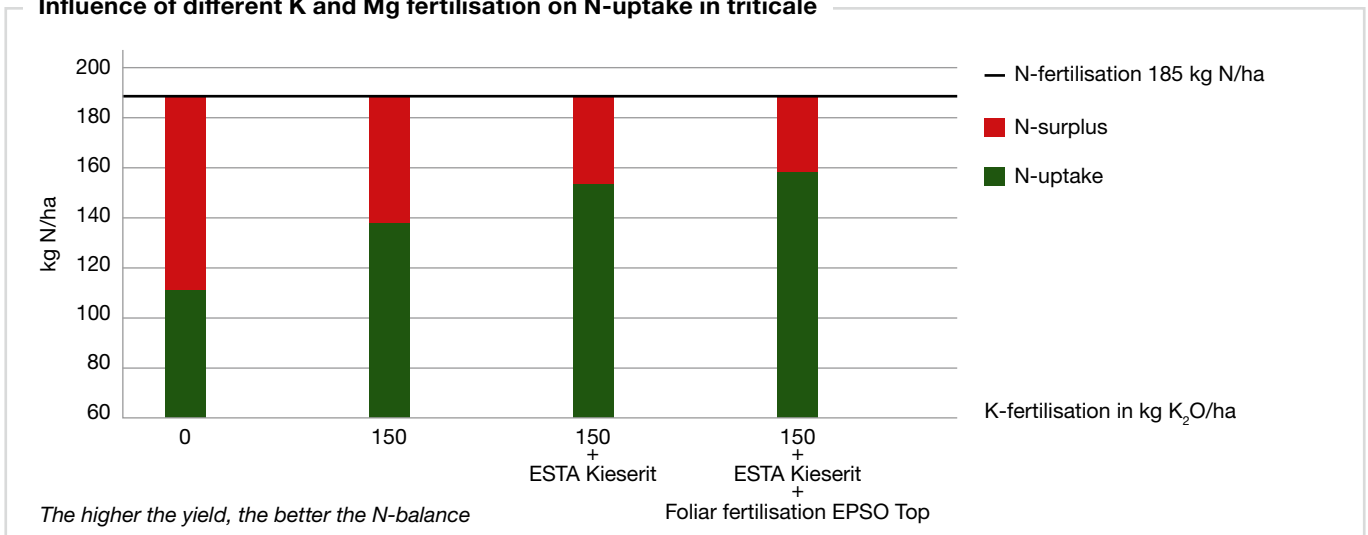
- Combined drilling with 100–200 kg/ha using N- or NP-fertilisers
- Band fertilisation with 200 kg/ha with or after sowing, also in combination with the hoe
- Broadcast fertilisation with 200–400 kg/ha
- Sulphur is essential for protein synthesis and therefore yield generation
- With a sulphur deficiency, nitrate, amino acids and amines accumulate in the plants, as they cannot be built into proteins.
- Thus, less nitrogen is taken up from the soil

**Magnesium for green energy**

As a main component of chlorophyll, magnesium is essential for the conversion of light energy to plant energy. Particularly in the main growth phase, large amounts must be taken up within a short period. As one of the few fully water-soluble magnesium fertilisers, ESTA Kieserit is available to apply as a straight fertiliser or as a component of various potassium fertilisers such as Korn-Kali or Patentkali.



**Influence of different K and Mg fertilisation on N-uptake in triticale**





# Natural power – through a unique compound. The perfect combination of Mg + S. For stronger growth.

**You would like to raise the protein content of your plants? You would like to optimise the protein content of your wheat or the oil content of your oilseed rape? Or would you like to improve your nitrogen efficiency? Whatever your target might be, with the natural power combination of magnesium and sulphur in our ESTA Kieserit you can realise everything effectively.**

**Achieve optimum plant growth with magnesium and sulphur – the unique combination in ESTA Kieserit.**

The naturally occurring mineral kieserite, found in combination with potassium crude salt, consists of magnesium and sulphur, which are both considered to be essential plant nutrients. The combination of both nutrients is super effective on quality and yield. Because both magnesium and sulphur are immediately plant available in ESTA Kieserit, the plants can immediately take

up both nutrients. As this strong combination is pH-neutral, there is no acidification of the soil. Furthermore, it improves the additional S supply of the plants and the utilisation of available nitrogen.

Thus, you can save the costs for nitrogen fertilisation, fulfil environmental specifications and at the same time improve the nitrogen balance of your crops. ESTA Kieserit is the value-for-money and highly efficient alternative to sulphur fertilisation with nitrogen fertilisers.

This also applies to sites with a relatively good magnesium supply. As many times shown, plants have a limited ability to acquire magnesium, because magnesium, unlike potassium and other nutrients, is only taken up passively (by mass flow). This magnesium shortage particularly comes into effect during extended dry periods.





## Symptoms of magnesium and sulphur deficiencies are clearly visible.



*In case of sulphur deficiency, the petals of oil seed rape are smaller than usual and have a light yellow to white color. Likewise, this can be seen in the flower density: the left plant is well supplied with sulphur, while the middle and right have a deficiency.*



*Sulphur deficiency leads to the occurrence of chlorosis and deforms leaves.*



*Typical symptoms of sulphur deficiency in barley.*



*Magnesium deficiency in rapeseed.*



*Magnesium deficiency in maize, visible on the stains between the leaf veins.*



*Winter wheat shows similar symptoms in case of magnesium-deficiency, which appear first on older leaves.*

## The nutrient magnesium – essential for energy supply and metabolism



Magnesium is one of the most essential components of chlorophyll. Chlorophyll performs the central function of plant growth, converting solar energy to biological/chemical energy during photosynthesis. Magnesium has therefore an important influence on the whole energy and metabolic performance of the plants.

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

Magnesium sulphate is completely water-soluble and therefore immediately plant available. The solubility of magnesium products can be found on the packaging label.

If “water soluble” is not stated on the label, then the product contains poorly soluble forms of magnesium, which are only available to the plants to a limited extent or not at all.

### The Function of magnesium:

- Up to 30 % of the total magnesium content of the plant is found in the chlorophyll and therefore it is essential for photosynthesis. Magnesium is the catalyst for the energy transformation with the aid of ATP.
- Magnesium plays an important role in the whole protein and carbohydrate metabolism. The storage capacity for assimilates in the reserve organs (grain, beet, tuber, etc.) is significantly co-determined by the magnesium content of the plant.
- Magnesium regulates over 300 enzyme reactions
- Magnesium stabilises the cell membrane and the plant vitality.
- Magnesium promotes root growth and thereby enables the plant to take up sufficient water and nutrients from deeper soil levels, even in dry phases.
- Magnesium deficiency during the growth phase equates with reduced photosynthesis rates and, therefore, with reduced yield and quality performance of the plant.
- Magnesium improves phosphate uptake and phosphate transport in the plant.
- Magnesium promotes nitrate reduction (reductase) and with it counteracts undesired nitrogen enrichment in the plant.

### Qualitative and quantitative characteristics depend on the magnesium availability

Crops	Effect of magnesium
Cereals	Increase in grain yield, grain weight, protein content
Legumes	Increase in yield, protein content and quality
Oil crops	Increase in yield and oil content
Potato	Increase in yield and quality
Sugar beet	Increase in beet and sugar yield
Vegetables	Improvement in the green colour and therefore the market value of green vegetables, reduction of the nitrate load
Fruits	Increase in the sugar and acid content of the fruits, formation of flavours, improvement in size and colouring of the fruits



ESTA Kieserit is your ideal low cost and environmental friendly fertiliser for all your crops. It can be used for both top-up fertilisation of low magnesium soils as well as regular fertilisation with magnesium and sulphur according to the requirement of the crop.



## The nutrient sulphur – essential for plant metabolism



Sulphate-based sulphur is highly efficient and is not leached out during the vegetative period, because during this time evaporation is higher than precipitation. The essential nutrients magnesium and sulphur mutually benefit each other during uptake by the plant – thanks to the synergy effect.

Sulphur fertilisation is nowadays indispensable for optimum plant growth. Magnesium sulphates, as in our ESTA Kieserit, are immediately plant available and pH-neutral. They also demonstrate no chalk draining effect like sulphur-containing nitrogen fertilisers. This is especially important for acid-sensitive barley. Targeted sulphur fertilisation with ESTA Kieserit can be performed regardless of the N-fertilisation.

### The Function of sulphur

- Improves nitrogen efficiency.
- Direct yield increase through efficient use of sulphur.
- Sulphur is essential for the synthesis of sulphur-containing amino acids and influences the whole protein synthesis.
- Sulphur activates important enzymes in energy and fatty acid metabolism and plays an important role in the creation of oils.
- Sulphur is a component of chloroplast protein.
- Sulphur is important for the formation of sulphur-containing secondary plant compounds (e.g. allium and mustard oils – influencing the taste and smell of various crops).
- Sulphur is a component of vitamin B1 (cereal grains, legumes).
- Sulphur is important for the production of the plant's own defences (phytoalexins, glutathione).
- Sulphur reduces nitrate in vegetables.



*Trial parcel of grain turned green after sulphur fertilisation.*



*Sulphur deficiency is also provoked by various soil types.*

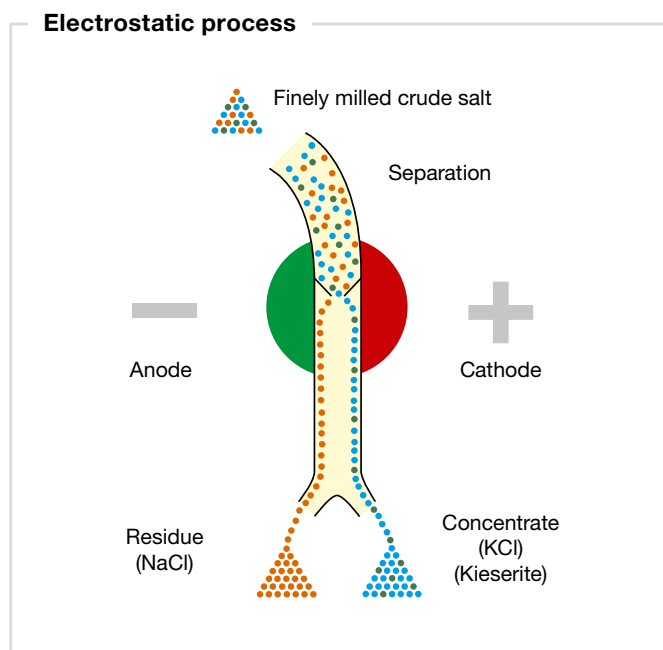
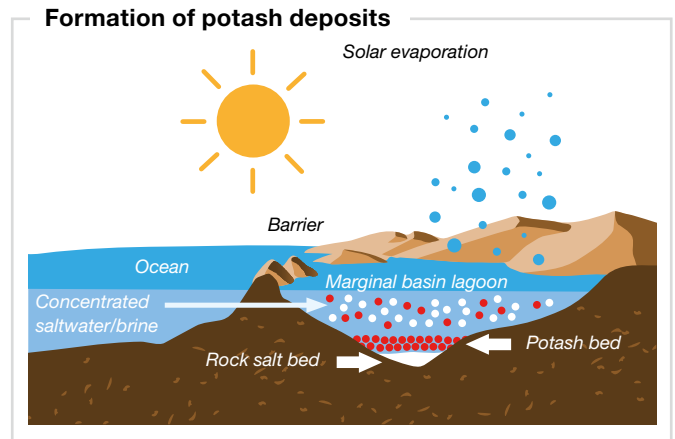


*Sulphur deficiency in maize*



# Natural power – from the depths of the earth. A natural product for a natural yield.

The natural potassium mineral deposits in Germany were formed around 250 million years ago through evaporation of the Zechstein Sea. According to the barrier theory, salt-rich seawater flowed over shallow straits into broad lowlands, where it evaporated due to strong solar radiation. The salt concentration rose; potassium, magnesium and sodium salts crystallised out and were deposited in the order of their solubility. This process repeated over many centuries so that two or more potassium deposits were created at several hundred meters depth. The salt deposits were then covered by powerful sediments in the course of the more recent earth's history, above all red sandstone, shell limestone and Keuper.

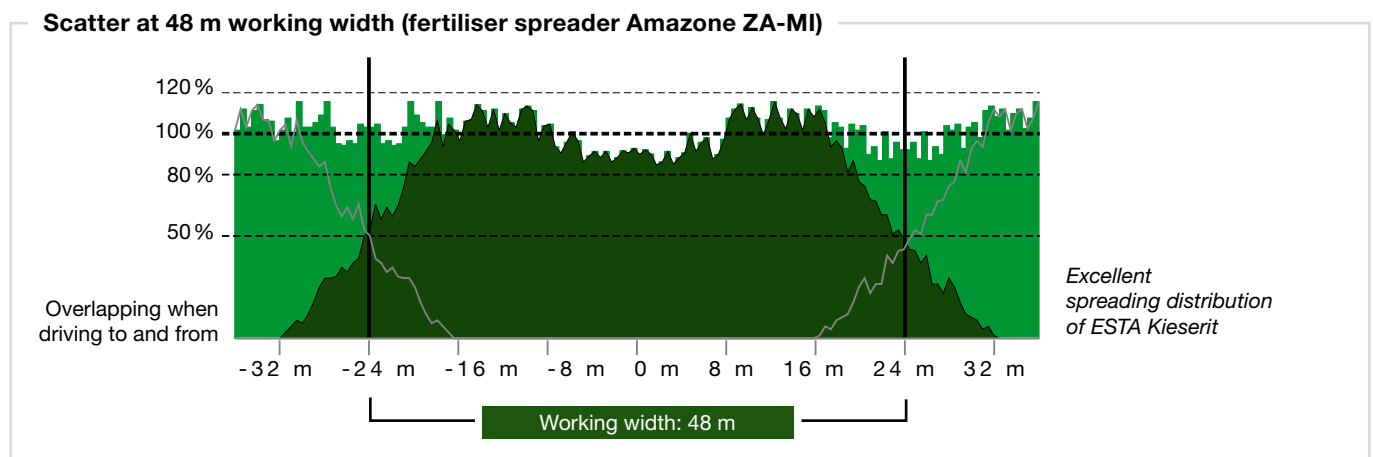


## Manufacturer

The raw material is the natural magnesium-containing mineral kieserite ( $MgSO_4 \cdot H_2O$ ), which is found in mined sylvinites in addition to potash and halite. Kieserite is separated using "electrostatic separation" (ESTA in short), an environmentally friendly dry separation procedure. The separation process, which does not require salt solutions and high energy input to dry the product, is based on a phenomenon that can be observed in everyday life: one rubs a material against another under specific physical conditions and they can give each other opposing "electrical" charges.

The ESTA Kieserite obtained in this way can be used directly as a fertiliser.

ESTA Kieserite is a round granulate with ideal spreading properties and therefore very suitable for spreading up to 48 m wide. Storage and handling do not necessitate special conditions.









# Strong know-how: Research & Advisory of K+S KALI GmbH

K+S KALI GmbH supports agricultural practice all over the world by providing expert knowledge on fertilisation, in order to achieve high yields and excellent quality, and to maintain these even under adverse climatic conditions. The foundation of the advice provided is our extensive research activity.

For more than 100 years, K+S KALI GmbH has been involved in agricultural research, always looking for solutions to agronomical challenges, such as how to increase productivity, how to improve soil fertility and how to efficiently use resources.

Together with the Georg-August-University of Goettingen K+S KALI GmbH today runs the Institute of Applied Plant Nutrition (IAPN). As an intersection between science and practice, the IAPN picks up on topical issues, pools existing knowledge and transfers new findings to agricultural practitioners.

The advisory service of K+S KALI GmbH as well aims at transferring existing and new research findings in the field of plant nutrition to agricultural practice. Farmers all over the world benefit from this know-how, which enables them to implement new and promising methods in their fertilisation practice, and to thereby improve yields and quality of their harvests. Our commitment and our expertise represent a significant contribution to securing global food supply and to protect the livelihoods of farmers.

Benefit from our agronomists' expertise and get more information on [www.kali-gmbh.com/fertiliser](http://www.kali-gmbh.com/fertiliser). Here you will find useful technical information, brochures and also our App, KALI-TOOLBOX.

For personal advice, call our Research & Advisory department in Kassel that might as well provide local contacts.





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