



FOLIAR FERTILISATION WITH SUCCESS

MAGNESIUM AND SULPHUR FOR QUALITY

EPSOTop®

EPSO
Microtop®

EPSO
Combitop®



k+s

The EPSO product range – water-soluble fertilisers for every need



EC FERTILISER
Magnesium sulphate 16+32.5

16 % MgO water-soluble magnesium oxide
32.5 % SO₃ water-soluble sulphur trioxide (= 13 % S)



EC FERTILISER
Magnesium sulphate with micronutrients 15+31

15 % MgO water-soluble magnesium oxide
31 % SO₃ water-soluble sulphur trioxide (= 12.4 % S)
0.9 % B water-soluble boron
1 % Mn water-soluble manganese



EC FERTILISER
Magnesium sulphate with micronutrients 13+34

13 % MgO water-soluble magnesium oxide
34 % SO₃ water-soluble sulphur trioxide (= 13.6 % S)
4 % Mn water-soluble manganese
1 % Zn water-soluble zinc



EPSO fertilisers of K+S KALI GmbH – products of natural origin

Where our products come from

- K+S KALI GmbH mines unique crude salts containing the mineral Kieserite (natural magnesium sulphate).
- EPSO products consist of magnesium sulphate heptahydrate directly derived from Kieserite.

Foliar application technique

- The EPSO products are rapidly acting magnesium and sulphur fertilisers developed especially for foliar application (at 5 % concentration). Due to the rapid dissolution of EPSO products they are also highly suited to use in fertigation systems.
- EPSO products dissolve instantly and completely in water.
- They are rapidly absorbed by the leaves once the solution is applied (more than 90 % absorption within 24 hours).
- They act independently of the soil pH, as the nutrients (Mg, S and, if required, Mn, B or Zn) are directly absorbed through the leaves.
- EPSO products come in the form of fine white crystals and are conveniently supplied in 25 kg polythene bags. They dissolve rapidly in water.
- As a general rule, we recommend a concentration of 5 % w/v (or 5 kg of EPSO fertiliser in 100 l of water).
- EPSO products can be combined with most crop protection products. Nevertheless, we recommend that you carry out a simple preliminary compatibility test in a bucket and that you follow the recommendations of the pesticide manufacturers: add 5 % EPSO fertiliser to a given volume of water, stir well and then add the plant protection product(s). If it dissolves completely, the products are compatible.
- To use the product, proceed as follows:
 - 1) Start filling the tank partially with water.
 - 2) Always dissolve the EPSO fertiliser first of all, adding it continuously into the tank with agitation.
 - 3) Continue filling the tank and add the other products.
- EPSO products are tolerated very well by crops (there is no phytotoxicity through scorching).
- The ideal application period is when temperatures are not excessive, either early in the morning or in the evening.
- If there is heavy rain within 24 hours, you are advised to re-apply.



Foliar applications of magnesium sulphate assure highest yields

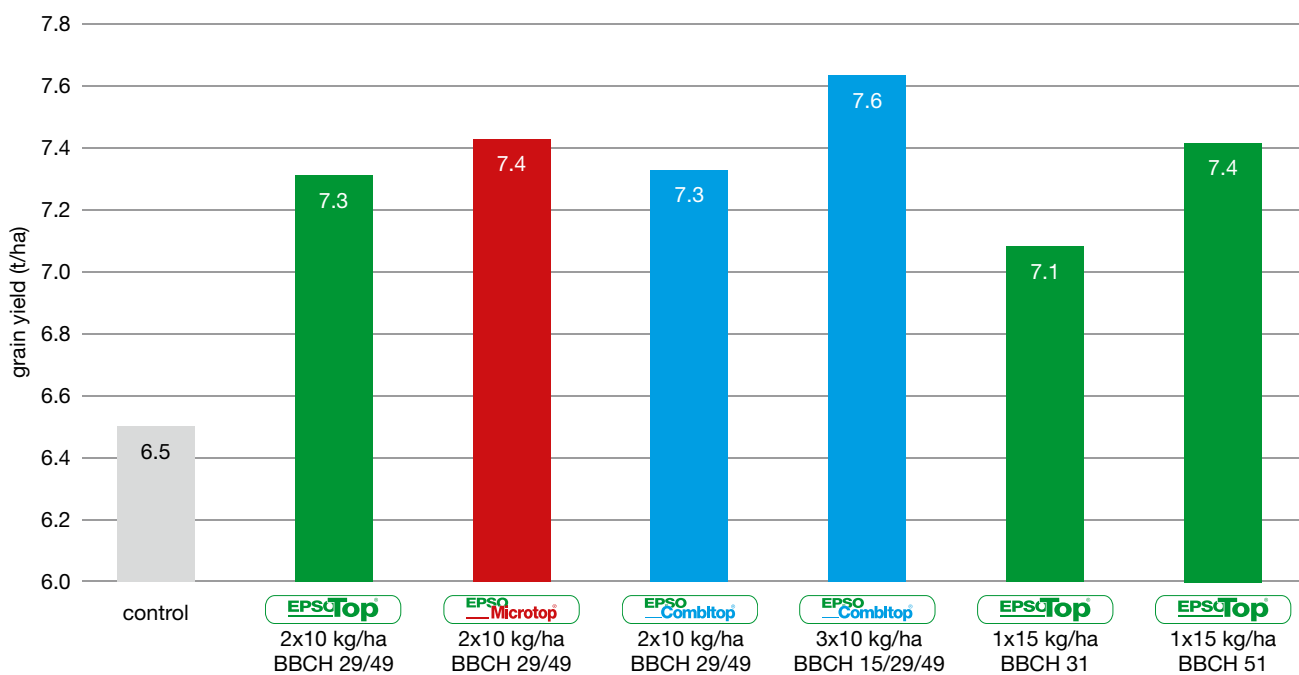
EPSO application affects crops in different growth stages. Early applications promote root growth. A well developed and deep reaching root system enables the crop to reach available water and nutrients from a deeper soil profile. This is especially of importance in years with severe drought either during spring or early summer.

Applications during later growth stages promote the transport of assimilates from the leaves to the storage organs such as grain, roots or tubers.

Thus, multiple EPSO applications are the best insurance to maintain optimal magnesium and sulphur supply and to achieve highest yields as well as best quality of the harvest product.



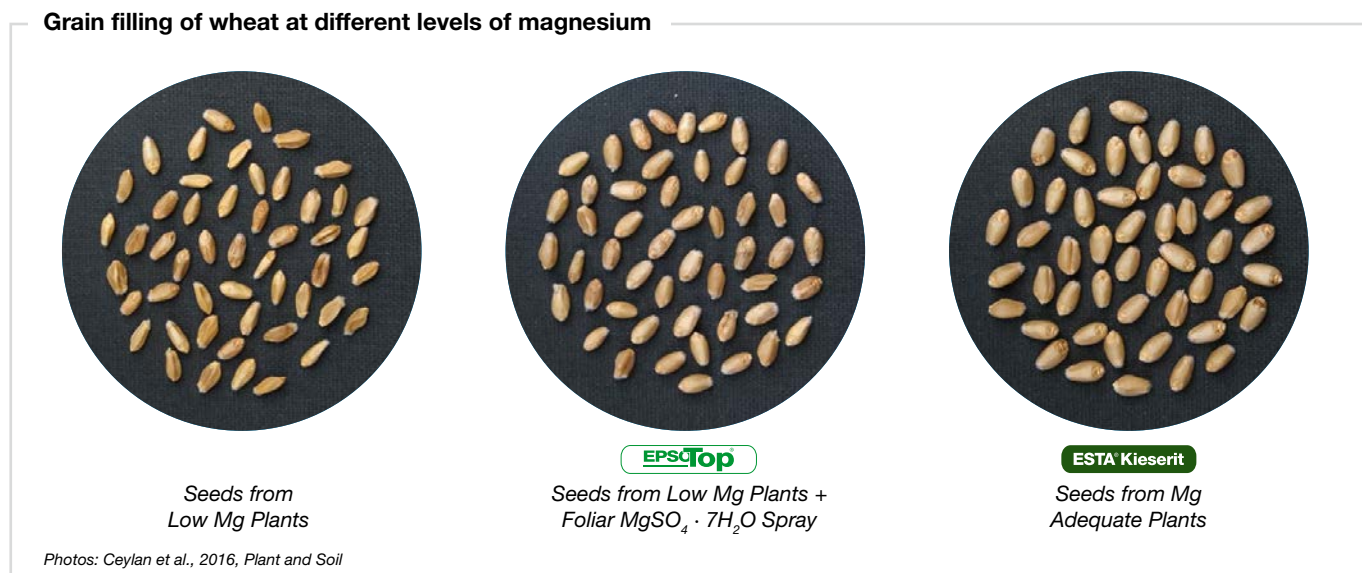
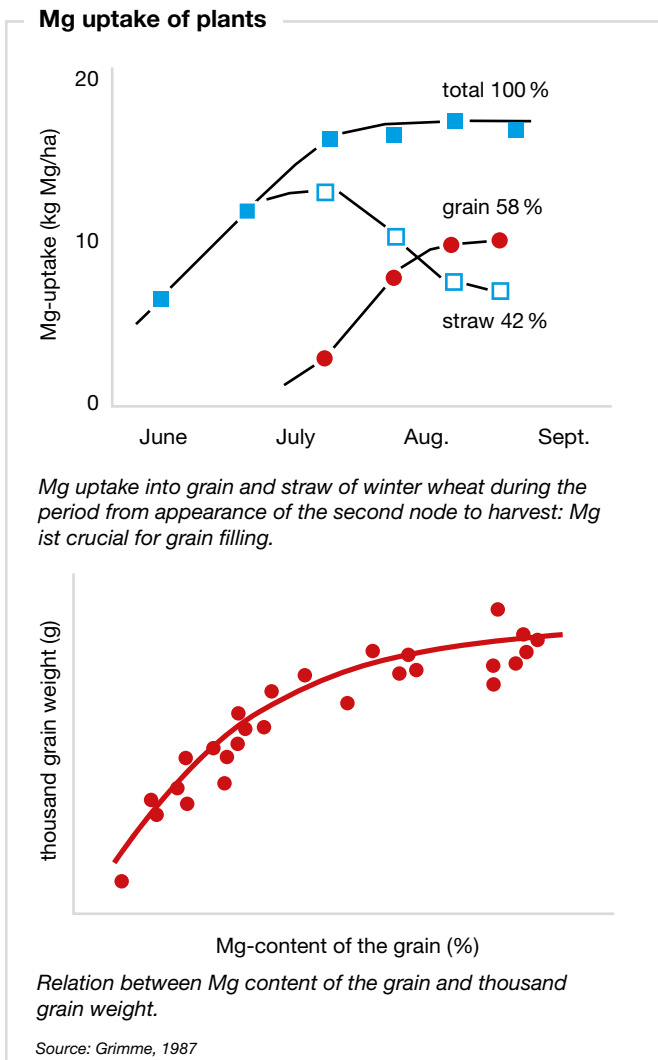
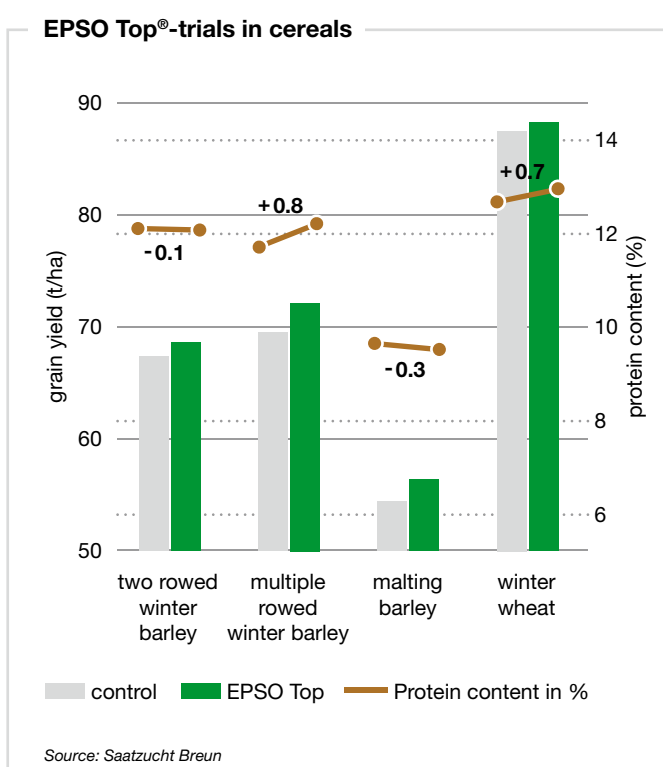
Grain yield of winter barley dependent on EPSO product and application frequency
Bramsche and Isernhagen 2015



All treatments were supplied with N, P and K as well as plant protection chemicals according to farmers practice.

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



Magnesium – essential for photosynthetic energy conversion and plant metabolism

Magnesium

Mg

24.31

12

Magnesium is one of the most essential components of chlorophyll. Chlorophyll performs the central function of plant growth – the photosynthesis where sun's energy is converted into biochemical energy which is used to synthesize carbohydrates from CO₂ and water.

- Up to 30% of the total magnesium content of the plant is part of the chlorophyll. Magnesium is the catalyst for 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 harvest product.
- Magnesium promotes root growth and thus enables the plant to access more water and nutrients in the soil.

Ensuring sufficient magnesium supply

Magnesium is an important fertiliser in most crop systems. Particular emphasis has to be taken on magnesium in these cases: 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 (MgSO₄) 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 very limited or not at all plant available.



Magnesium deficiency in winter wheat



Magnesium deficiency in oil seed rape

Sulphur – essential for the metabolism of the plant

Sulphur

S

32.07

16

Sulphur fertilisation is essential

Air pollution control measures have reduced the average atmospheric sulphur deposition to only 5-10 kg S/ha/year in Germany (previously about 10-time higher) 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.

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, which increases nitrogen use efficiency.
- is involved in the synthesis of sugar, starch, vitamins and flavourings.
- is needed by oil plants for oil production.



Grain field turned green after sulphur fertilisation.

Sulphur deficiency – a more and more frequently occurring symptom

In grains:

Low thriftiness, yellowing, rigidity of the plant. This is easy to mistake for nitrogen deficiency. Nitrogen deficiency leads to yellowing of the whole plant-, and sulphur deficiency affects young leaves first.

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 is also provoked by varying soil conditions.



Sulphur deficiency in maize

EPSoTop®

Magnesium & Sulphur – to close nutrient gaps



EPSoTop®

EC FERTILISER

Magnesium sulphate 16+32.5

16 % MgO water-soluble magnesium oxide
32.5 % SO₃ 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, completely plant available and are present in sulphate form (MgSO₄ · 7 H₂O).
- 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 allowed for use in organic agriculture pursuant EC regulations 834/2007 and 889/2008.



EPSO Top® foliar fertilisation

- A single or multiple application with 25 kg/ha in 5 % concentration (5 kg/100 l water) is recommended to meet the peak requirement and to counteract latent deficiency. In case of severe deficiency and/or visible deficiency symptoms, up to 50 kg/ha, split into two to four partial applications should be applied.
- EPSO Top can be mixed with most insecticides and fungicides as well as with growth regulators and herbicides so that combined use is possible. However, the manufacturer's recommendation for mixtures should be followed. EPSO Top should be dissolved before the plant protection product is added.
- Miscibility can be tested by mixing and dissolving a sample of EPSO Top with the respective plant protection product in a test vessel. If the mix fully dissolves, then the products can be safely applied together.
- EPSO Top can also be applied in an aqueous solution in combination with other liquid fertilisers, ammonium nitrate-urea solutions as well as NP and urea solutions. Therefore EPSO Top has to be dissolved in water first.

Crops	Application time	BBCH state	Concentration (in %)
Cereals	from the end of tillering until the fruit development	29–71	5*
Rape	rosette stage until flowering	30–57	5
Peas, beans	prior to flowering	up to 59	5
Potatoes	prior to and during flowering	51–69	3–5
Beets	at row closure	31–39	5
Maize	with corn borer treatment	up to 59	5
Fruit	at fruit formation, with scab treatment, repeatedly	71–79	2–3
Hops	one to two times until flowering	60–69	2–5
Vine	until early August at the latest, one to two times	9–17 and 25	3–5
Asparagus	with sufficient leaf mass		3–10
Vegetables	with fungicide / insecticide treatment	up to 59	2–3
Conifers	repeatedly in case of yellowing or browning		3–5
Greenhouse crops	drip irrigation	up to 59	2–3

*equivalent to 5 kg EPSO Top/100 l water

EPSO Top[®]: Versatile foliar fertiliser – suitable for all crops

Cereals

Two critical phases during cereal growth determine the application period of EPSO Top. Visible magnesium deficiency symptoms often occur at the start of stem elongation. The ripening and grain formation period is also critical. A high magnesium and sulphur content is essential to keep the flag leaf long in the green phase and thus to ensure photosynthesis.

Oil seed rape

The cruciferous plants react most severely and visibly to magnesium and also sulphur deficiency. EPSO Top should be applied as foliar fertiliser repeatedly during stem elongation until the flowering phase to help meet the magnesium and sulphur requirement of the rape plants.

Sugar beets

Foliar fertilisation with EPSO Top during row closure has a significant effect on the yield formation as well as the quality of the beets. This leads to an optimised nitrogen metabolism and thus to an improved quality of the sugar beets.

Potatoes

The magnesium and sulphur requirement of the potato plant peaks during tuber initiation and the tuberisation phase – parallel to the flowering phase. The supply via the leaf keeps the photosynthesis rate stable so that deficiencies are prevented during tuberisation.

Hops

EPSO Top is applied shortly prior to or directly during flowering in combination with crop protection treatments. The application is repeated during the cone development (3–4 weeks after flowering), because the magnesium and sulphur requirements then reach their peak.

Asparagus

The green asparagus leaves produce the reserve substances for the coming spring and thus determine the yield the following year. Magnesium deficiency quickly leads to yellow and consequently dead asparagus leaves and thus to a shortened storage phase. A single or multiple EPSO Top application can counteract this effect. Application rate: 50 kg EPSO Top per hectare and year.

Due to the small green mass of asparagus leaves, the EPSO Top concentration can be increased up to 10% (10 kg EPSO Top per 100 l water) for small spraying volumes.

Conifers

Conifers – firs, spruces, etc. – often exhibit discoloured needles. These discolorations – magnesium deficiency – change from light green to yellow and brown. A repeated treatment with EPSO Top can quickly and successfully counteract this phenomenon.



EPSO Microtop®

The special foliar fertiliser – extra boron and manganese



EPSO
Microtop®

EC FERTILISER

Magnesium sulphate with micronutrients 15+31

- 15 % MgO** water-soluble magnesium oxide
- 31 % SO₃** water-soluble sulphur trioxide (= 12.4 % S)
- 0.9 % B** water-soluble boron
- 1 % Mn** water-soluble manganese

EPSO Microtop®

- is an immediately effective foliar fertiliser with the nutrients magnesium and sulphur as well as boron and manganese. All nutrients are in water-soluble form.
- meets the increasing requirement for micronutrients.
- can be immediately and completely absorbed via the leaf and is quickly effective.
- helps prevent magnesium, sulphur, boron, and manganese deficiencies during the growth phase quickly and reliably.
- is especially suitable as cost-effective prophylactic measure for the prevention of deficiencies.
- its effectiveness does not depend on the soil pH, because the nutrients are directly absorbed via the leaf.
- allows for a quick, targeted and precise application of boron and manganese in combination with magnesium and sulphur.
- should only be applied to boron-sensitive crops like cereals, strawberries, etc., if the boron content of the soil or the plants is known.
- is allowed for use in organic agriculture pursuant EC regulations 834/2007 and 889/2008.

EPSO Microtop® – combines four important nutrients



Magnesium deficiency in maize

Magnesium

- is an essential nutrient for the yield and quality formation of the plants.
- is involved in the efficiency of photosynthesis as the central atom in the 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 as well as during periods of cold, drought or in soils with insufficient magnesium availability.

Sulphur

- is a vital nutrient, especially for protein synthesis therefore increasing nitrogen efficiency.
- is absorbed as sulphate (SO_4^{2-}) via the root and the leaf.
- is becoming increasingly important, as sulphur emissions have significantly decreased due to air pollution control measures.

Boron

- is important for cell wall formation, water balance as well as the production of energy-rich assimilates such as sugar and starch.
- has a narrow effective range between removing deficiencies, an optimum supply and toxicity. A precise boron fertilisation fitting to the boron requirement of the plant is therefore essential.
- deficiency symptoms often occur after periods of drought and include death at the growing points, deformation and death of the youngest leaves, stunted growth, thickened stems, cracked tissues and shortened leaf lamina.



Boron deficiency in sugar beets (heart rot)

Manganese

- activates a variety of enzymes and therefore manganese plays an important role in the metabolism of the plant.
- is essential for chlorophyll as well as photosynthesis, for nitrate reduction and the production of amino acids.
- increases the disease-resistance of the plants.
- availability significantly decreases with increasing soil pH. Drought or good soil aeration increases manganese fixation. Therefore, foliar fertilisation is the only immediate and reliable solution.



Manganese deficiency in sugar beets

EPSO Microtop® – application recommendations



Manganese deficiency in potatoes



Sulphur deficiency in rape

EPSO Microtop®

- 25 kg EPSO Microtop per hectare supply the plants via the leaf with 3.75 kg MgO, 7.5 kg SO₃, 225 g boron and 250 g manganese. One or two treatments meet the peak requirement of the crops for magnesium and sulphur as well as their total maintenance requirement for boron and manganese.
- dissolves without any residue (no clogged nozzles)
- can be mixed with most plant protection products and liquid fertilisers. Manufacturer's instructions must be followed.
- is delivered in handy 25 kg bags.
- is good storable and therefore easy to handle.
- is efficient: EPSO Microtop enables a cost-effective nutrient supply of magnesium, sulphur, boron and manganese without any additional costs for the application, if this measure is combined with plant protection treatments.
- helps eliminate magnesium, sulphur, boron, and manganese deficiency symptoms quickly and reliably.

Note

A single or multiple treatment with 25 kg/ha in 5 % concentration (5 kg/100 l water) is recommended to meet the peak requirement and to counteract latent deficiency. In case of severe deficiency and/or visible deficiency symptoms, the application rate should be increased up to 50 kg/ha, split into two to four applications.

Crops	Application time	BBCH state	Concentration (in %)
Sugar beets	from row closure	31–39	5
Oil seed rape	from rosette stage until flowering	30–57	5
Cabbages	from 6 leaf stage until half head size	16–45	5
Potatoes	with potato blight treatment	from 21	3–5
Sunflowers	from 8 leaf stage until flowering	18–53	5
Maize	until 10 leaf stage	from 59	5
Vine	from 3 leaf stage until prior to flowering and post-flowering until early August	9–17 25	3–5

EPSO — Combitor®

The foliar fertiliser – ideal for cereals



EPSO — Combitor®

EC FERTILISER

Magnesium sulphate with micronutrients 13+34

13 % MgO water-soluble magnesium oxide

34 % SO₃ water-soluble sulphur trioxide (= 13.6 % S)

4 % Mn water-soluble manganese

1 % Zn water-soluble zinc

EPSO Combitor®

- is especially formulated for the micronutrient requirement of cereals in an ideal combination with magnesium and sulphur.
- is an immediately effective foliar fertiliser with the nutrients magnesium and sulphur and additionally manganese and zinc. All nutrients are in the water-soluble, plant available form.
- meets the increasing requirement for micronutrients.
- can be immediately and completely absorbed via the leaf and is thus quickly effective.
- is ideal for autumn application in winter barley to reduce the susceptibility to crop failure during the winter.
- is especially suitable as cost-effective measure for the prevention of deficiencies.
- effectiveness does not depend on soil pH, because the nutrients are directly absorbed via the leaf.
- allows for a quick, targeted and precise application of manganese and zinc in combination with magnesium and sulphur.
- is allowed for use in organic agriculture pursuant EC regulations 834/2007 and 889/2008.



Sulphur deficiency in barley



Manganese deficiency in wheat



Without micronutrient fertilisation in autumn, significant crop failure occurs.



Magnesium deficiency in rye



Zinc deficiency in maize

Aside from magnesium and sulphur, manganese and zinc are of special importance for cereals.

Manganese

- activates a variety of enzymes and therefore plays an important role in the metabolism of the plant.
- is essential for chlorophyll synthesis and photosynthesis as well as for nitrate reduction and the production of amino acids.
- increases the disease resistance of the plants.
- availability significantly decreases with increasing soil pH. Drought or good soil aeration increases manganese fixation. Therefore, foliar fertilisation is the only immediate and reliable solution.

Zinc

- is essential for protein synthesis, which is inhibited in case of zinc deficiency.
- is necessary for the stability of ribosomes.
- is important for the longitudinal growth of plants. Typical symptoms of zinc deficiency are stunted growth, small-sized leaves and rosette formation. Wheat shows yellow-white spots, which can change into stripes along the whole leaf.

EPSO Combitor® – application recommendations

EPSO Combitor®

- serves as foliar fertiliser for effective prevention as well as treatment of acute deficiency. All nutrients are fully water-soluble, absorbed via the leaf within a short time and are therefore fast-acting.
- 25 kg EPSO Combitor per hectare supply the plants via the leaf with 3.25 kg MgO, 8.10 kg SO₃, 1000 g manganese and 250 g zinc. One or two treatments meet the peak requirement of the crops for magnesium and sulphur as well as their total maintenance requirement for manganese and zinc.
- dissolves without any residue and is very plant compatible.
- can be used in mixtures with most plant protection products and liquid fertilisers. The technical mixability for the production of residue-free solutions has to be tested prior to the application. The information of the manufacturer has to be followed.
- is delivered in handy 25 kg bags, storable and easy to handle.
- is usually applied as 5 % EPSO Combitor solution (5 kg/100 l water). This concentration can also be used in mixtures with plant protection products. After mixability with the plant protection product has been tested, a combination is possible in the following order: Fill plant protection sprayer with 1/3–1/2 water > EPSO Combitor > plant protection product.
- for cereals, is usually used in combination with crop protection measures in spring. The recommended rate is 2 x 10 kg EPSO Combitor per hectare from the onset of vegetation. An immediate treatment is recommended if deficiency symptoms are already visible. Soils known for deficiencies should be additionally treated in autumn with 10 kg /ha from BBCH 15 on, which is cost-effective even if a separate pass with the sprayer is needed.

Crops	Application time	BBCH state	Concentration (in %)
Cereals	from the end of tillering until the fruit development	29–71	5*
Maize	with corn borer treatment	up to 59	5
Potatoes	prior to and during flowering	51–69	3–5
Fruit	at fruit formation, with scab treatment, repeatedly	71–79	2–3
Vegetables	with fungicide / insecticide treatment	up to 59	2–3

*equivalent to 5 kg EPSO Top/100 l water





Deficiency symptoms ABC – quick and reliable

Nutrient requirements vary from crop to crop. Our K+S KALI GmbH agronomists are prepared to support you by providing essential information on optimal crop nutrition.

If your plants show acute deficiency symptoms, you may use our Nutrient Deficiency ABC on our website www.kali-gmbh.com or within our App “KALI-TOOLBOX” to identify what is missing. Here you will see right where you are, in the field, which nutrients your plants are lacking.

As soon as you have identified the problem, K+S KALI products with their high nutrient availability will fix it immediately.

Additionally, KALI-TOOLBOX contains a nutrient converter that helps to calculate different forms of nutrients.



Our App is for free!

Search for „KALI-TOOLBOX“ in your store:



www.kali-gmbh.com/deficiency-symptoms



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

K+S KALI GmbH supports agricultural practice all over the world by providing professional expertise on fertilisation, in order to achieve high yields and excellent quality, even under adverse climatic conditions.

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 Georg-August-University of Goettingen K+S KALI GmbH today operates 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 practice.

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 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 crops. 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. Here you will find useful technical information, brochures and also our App, KALI-TOOLBOX.

For personal advice, call our Advisory service in Kassel, Germany, that might as well provide local contacts.

How to contact us

Detailed information on all K+S KALI GmbH fields of expertise can be found at: www.kali-gmbh.com

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