International Plant Nutrition Institute

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Sulphate of Potash for Quality

Kali Export Gesellschaft

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Sulphate of Potash for Quality
Why Sulphate of Potash?

More than 95% of all the potash used in world agriculture is muriate of potash (potassium chloride), indicating that this is the most easily obtainable, most generally useful and most economical form. What, then, are the special virtues of sulphate of potash which sometimes justify its use in preference to muriate and also justify the premium price which it commands?

The Need for Sulphur

Sulphate of potash is less concentrated in potash (50% K₂O) than muriate (60% K₂O) but the sulphur which it contains is useful to plants. We commonly talk about fertilizer in terms of N, P, and K as though these were the only main foods of plants but sulphur is actually a very important plant food – plants take up sulphur and phosphorous in roughly the same amounts.

In industrial areas appreciable amounts of sulphur, originating from the burning of coal and oil, are added to the soil in rainfall. It is therefore not surprising that sulphur deficiency is rare. However, the clean-air legislation which most countries now enforce will greatly reduce this fortuitous supply.

Until some years ago, the older nitrogen and phosphorous fertilizers like sulphate of ammonia and superphosphate contained much sulphur; the average farmer then applied sulphur to his crops without making any conscious effort to do so. But these fertilizers have been superseded by new more concentrated and ‘purer’ materials like ammonium nitrate, urea and diammonium phosphate which do not contain sulphur. Sophisticated chemicals free of sulphur have replaced the old-fashioned sulphur-containing fungicides.

The result is that, even in industrial areas, sulphur deficiency occurs more often than it used to.

Except on rape seed and vegetables, sulphur deficiency is still comparatively rare in industrial areas but many soils in the tropics are low in sulphur and sulphur shortage often limits crop yield. In fact some of the spectacular yield increases obtained by applying superphosphate were due as much to the sulphur in this fertilizer as to the phosphate.
The changes which have taken place in industrial countries and the research done in parts of the world where soils are low in sulphur have both brought the problem very much to the fore.

**Sulphur Matters**

**Sulphate of potash — a dual fertilizer**

Sulphate of potash supplies two plant foods: potash and sulphur. It is actually a more concentrated fertilizer than muriate of potash even though its potash content is lower:

<table>
<thead>
<tr>
<th>Sulphate of Potash</th>
<th>Muriate of Potash</th>
</tr>
</thead>
<tbody>
<tr>
<td>50% K₂O</td>
<td>60% K₂O</td>
</tr>
<tr>
<td>+18% S</td>
<td>0% S</td>
</tr>
<tr>
<td>68% nutrients</td>
<td>60% nutrients</td>
</tr>
</tbody>
</table>

There are several ways of adding sulphur to the soil but it will often be the case that, when a crop needs potash fertilizer, using sulphate of potash is the cheapest and most convenient way of buying the sulphur which it also needs.
Other Special Properties of Sulphate of Potash

Low salt index
Sulphate of potash is less 'salty' than muriate – in technical terms its salt index per unit K₂O is only one half that of muriate. This makes it the better fertilizer where soils tend to be saline or where, as in intensive vegetable growing and in glasshouses, heavy rates of fertilizer are used, or when fertilizer is placed near delicate germinating seedlings.

Absence of chloride
While chloride is easily washed out of many soils and, in moderate amount, does no harm to most crops, there are crops which are very prone to chloride damage and upon which chloride-containing fertilizer should not be used. Sulphate of potash is virtually free from chloride – containing normally less than 2.5%. Industry offers also a special 'low chloride' quality (LC) with less than 1% or even 0.5% since these qualities are recommended in specific cases.

Physical properties
Sulphate of potash is non-delicacious and stores well even in damp climates. It causes no problems when it is a constituent of mixtures. It is available either as a crystalline powder (particle size around 0.15 mm) with very little dust, or in granular (compacted) form (1–3 mm size range).

Sulphate of Potash should be Your Choice Whenever or Wherever:
- Soil sulphur is low
- Sulphur requirements of crops are high
- Chloride-sensitive crops are grown
- Very high rates of fertilizer are used continually
- Soil salinity is a problem
- Crop quality is a first consideration
Crops

Crops for which there is well-documented evidence that sulphate of potash should always be used are:

Tobacco: Sulphate invariably gives a better-coloured leaf with much superior burning properties. The market is most aware of quality and the extra price obtainable for better quality leaf will always more than repay the cost of using sulphate of potash. With quality commodities like this, low grade produce may find no market at all.
In many countries the utilization of sulphate of potash is compulsory. It is also recommended to the tobacco growers to use only ‘low chloride’ forms of sulphate of potash.

Soft fruits are most sensitive to chloride damage, the symptoms of which appear similar to those of potash deficiency. Raspberries, strawberries and red currants are the most sensitive.

Tree fruits are rather less particular though the stone fruits are more sensitive to chloride than apples and pears. Higher yields of apples have been

Potassium sulphate for tobacco

| Cuba |  
|---|---|---|---|
| $K_2SO_4$ improves combustibility of high-grade tobacco |

<table>
<thead>
<tr>
<th>Glowing time (seconds)</th>
<th>12</th>
<th>28</th>
<th>104</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizer treatment</td>
<td>NP</td>
<td>NPK$_1$</td>
<td>NPK$_2$</td>
</tr>
</tbody>
</table>
obtained from sulphate of potash in experiments in France and the Netherlands.

**Citrus:** The sulphate form is often recommended and used, due to the lower salinity risks.

**Tea:** Some tea planters successfully use sulphate of potash which increases the dry matter and starch contents of the leaf. Sulphur deficiency (‘yellow disease’) is frequent in young plantings.

**Vegetables:** Several of these crops have a high requirement for sulphur and/or are sensitive to chloride; for example runner, dwarf and broad beans, the onion family, cucumber, melon, cabbage, and radishes. Others, less sensitive, which generally give more reliable results with sulphate are: tomato, cauliflower, peas, spinach, and red beet.

**Oil crops:** All oil crops have a high S-requirement. S favours N-fixation in soybeans and groundnuts, and higher oil contents have been obtained by the application of sulphate of potash in castor, rape- and linseed. Production of rapeseed almost doubled in the last decade, and even in industrial countries S-deficiencies can be observed.

### Potassium sulphate for groundnuts

![Bar chart showing the effect of NPK treatment on yield in Pakistan.](chart.png)

<table>
<thead>
<tr>
<th>NPK treatment, kg/ha</th>
<th>0-0-0</th>
<th>22.4-0-0</th>
<th>22.4-44.8-0</th>
<th>22.4-44.8-44.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Av. yields, kg/ha</td>
<td>1508</td>
<td>1790</td>
<td>2108</td>
<td>2346</td>
</tr>
</tbody>
</table>

41 trials, 3 years
Crop Quality

The special properties of sulphate of potash have earned it a well-deserved reputation for conferring high quality on crop produce.

Tobacco, in which quality is even more important than yield has already been mentioned.

Potatoes: The 'quality' of potatoes depends very much on variety, on the type of soil and on the purpose for which they are used. It is generally accepted that sulphate gives a mealer and better tasting potato. There is conclusive evidence that potatoes treated with sulphate of potash have higher dry matter and starch contents, which are most important when the crop is grown for industrial processing, alcohol production, etc. Some manufacturers of processed potato specify that the crop offered should be grown with sulphate of potash.

Apart from the effects on composition, sulphate gives more evenly shaped and generally smaller potatoes than muriate. This is an advantage in the seed crop and when potatoes are sold for crisp manufacture.

As regards yield, there is little to choose between the potash forms but

Potassium sulphate for potatoes

<table>
<thead>
<tr>
<th>Variety</th>
<th>none</th>
<th>as KCl</th>
<th>as K₂SO₄</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burbank</td>
<td>3.1</td>
<td>3.0</td>
<td>2.6 *)</td>
</tr>
<tr>
<td>Targhee</td>
<td>2.9</td>
<td>2.7</td>
<td>2.8</td>
</tr>
<tr>
<td>A 6371-2</td>
<td>3.2</td>
<td>2.8</td>
<td>2.6 *)</td>
</tr>
<tr>
<td>Nampa</td>
<td>2.3</td>
<td>2.1</td>
<td>1.7 *)</td>
</tr>
<tr>
<td>Mean</td>
<td>2.88</td>
<td>2.65</td>
<td>2.43</td>
</tr>
</tbody>
</table>

Yield increase = 5.6 - 7.8 t/ha

1) Mean values of 5 replicates of 25 tubers each
2) Statistically significant at p = 0.05

Blackspot bruise incidence in USA 1, 2

5.0 - maximum damage
Potash treatment: 280 kg K₂O/ha
there is some evidence that, while muriate gives the higher yield when potash is applied at low or moderate rate, sulphate gives the higher yield when heavy rates of potash fertilizer must be used.

Vegetables: Using sulphate of potash results in higher dry matter content (less moisture) in many crops. The higher the moisture content of the produce the more liable it is to mechanical damage in passing through the markets and the more liable it is to deterioration in stores. The extra firmness of crops like lettuce, onions and cabbages can well repay the extra cost of sulphate of potash.
More yield and better quality

<table>
<thead>
<tr>
<th>Treatment kg/ha</th>
<th>N</th>
<th>P₂O₅</th>
<th>K₂O</th>
<th>Fruit, t/ha</th>
<th>Juice, ml/fruit</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>29.3</td>
<td>11.6</td>
</tr>
<tr>
<td>P₂O₅</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>61.1</td>
<td>18.4</td>
</tr>
<tr>
<td>K₂O</td>
<td>0</td>
<td>0</td>
<td>230</td>
<td>155.3</td>
<td>239.9</td>
</tr>
</tbody>
</table>

Fruit: There is evidence that fruits grown with sulphate of potash are better and more uniformly coloured and of superior flavour to those grown with muriate. In practice, progressive fruit and wine growers in Europe use exclusively sulphate of potash.

Among tropical fruits, there is evidence of the superiority of sulphate of potash for quality in pineapple (flesh colour and fruit size and, in some cases for yield also).

In general, flowers grown with sulphate of potash are better coloured.

Crops in rotation

When very sensitive crops like tobacco are included in the rotation, it is advisable to use sulphate of potash also on the other crops even though they may themselves be chloride tolerant.

It may well be that because most of the 'quality' crops are commonly grown intensively with heavy fertilizer dressings, some of the advantages of sulphate of potash result from effects on the soil (see next page).

It is certainly true that, learning from experience, the great majority of horticulturists prefer this fertilizer.
Soils

Soil properties are relevant to the choice of potash fertilizer.

Soils low in sulphur
The visual symptoms of sulphur deficiency are similar to those of nitrogen deficiency:
- Leaves, including veins, are pale green; shown first on the younger leaves.
- Brittle, woody stem with stunted growth.
- Fruit pale and greenish with delayed ripening.
- Reduced nodulation of legumes.
- Effects on composition include lower protein and sugar contents with an increase in non-protein nitrogen.

When soil sulphur is low, using sulphate of potash will correct the deficiency. Crops like legumes, the onion family and cabbage, rapeseed, radishes which need much sulphur will respond the most readily. However, even crops which are chloride tolerant and have only a moderate sulphur requirement will respond when the soil is deficient in sulphur. For instance, large responses by grass have been reported from Brazil, New Zealand, France, and Ireland, and responses by wheat from Australia and the USA.

Intensive fertilizer use
When very high rates of fertilizer are used continually as in traditional market gardens and, more particularly, under glass or in pot culture where the volume of soil is restricted, there is danger from high chloride concentrations. Sulphate of potash should always be used under these circumstances.

Low phosphate soils
Because of the way in which the various constituents of fertilizers interact in the soil and in the plant sulphate of potash tends to favour the uptake of phosphate by the plant.

Saline soils
Salinity is a problem in arid areas where saline soils occur naturally and where salts build up by evaporation in irrigated soils. Except in cases where sulphates have accumulated, sulphate of potash is preferred to murtrate on account of its low salt index.
Management Practices

Field management, including the method and timing of fertilizer application may affect the choice of potash fertilizer.

Placement

It is possible to economize in fertilizer by placing it near to the seed and this practice is often advised on soils which fix phosphate or potash. A side-effect of placement is high salt concentration near the seed which can harm germination. Substituting sulphate for muriate lessens this danger. Similarly, deep placement of potash as advised in potash deficient orchards and vineyards carries a risk of causing high salt concentration near the growing roots; this risk is lessened by using sulphate of potash.

Time of application

Some of the less desirable effects of muriate of potash are minimized, in temperate climates, by putting on the potash in the autumn when the winter rains will wash the chloride out of the rooting zone. If, for one reason or another, potash cannot be applied until spring, sulphate of potash should be used.

Foliar fertilizer

This is used in specialized growing systems (as pineapples) and is sometimes used as a 'first aid' measure on crops on which a nutrient deficiency has been noticed, which if uncorrected will limit yield. Solutions of muriate of potash could cause more or less severe scorch; sulphate of potash, however at normal concentrations, say up to 2%, carries no such risk.
Generally recommended rates in kg/ha
sulphate of potash

- Cotton, forestry nurseries: 150–250
- Lettuce & other leafy vegetables, peas and beans: 200–300
- Citrus, coffee, bulb plants, flowers: 200–400
- Tobacco, potato, tomato, rapeseed: 300–500
- Grapes, berries, stone fruits: 300–600
- Alfalfa, cabbages: 400–600
- Pineapple: 600–1200

Sulphate of Potash
=50% K₂O + 18% S

Sulphate of Potash
- Supplies two plant foods – K and S
- Is a concentrated fertilizer 50% K₂O + 18% S
- Is non-hygroscopic and stores well
- Has no damaging side-effects
- Is essential for crop quality.

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