



Importance of Sulphur in Oilseed Crops

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India is largest producer and consumer of vegetable oil in the world. Oilseed have been the backbone of agricultural economy of India since long. Oilseed crops are one of the most important crops in the world, they are Sunflower, groundnut, sesame, safflower, mustard and rapeseed. India is largest producer (36.10 million tonnes) and consumer (250 lakhs metric tonnes per year) of edible vegetable oil. Oilseed crops are primary grown for edible oil. Sulphur is the fourth major plant nutrient after Nitrogen (N), Phosphorus (P), Potassium (K). It is the 13th most abundant element in the earth's crust with an average concentration of 0.06 percent. It is necessary for the synthesis of proteins, oils, and vitamins. Plant can absorb Sulphur only through their root system in the SO_4^{2-} form. Indian agricultural soils have a low concentration of inorganic Sulphur compared to the organic form. Sulphur deficiency leads to 40 % reduction in the quality and quantity of oilseed. Sulphur deficiency is becoming very common in many states of India.

Role and Function of Sulphur

- ❖ Sulphur is the essential constituents of S containing amino acids, viz. cysteine, cystine and methionine.
- ❖ All nitrogenases have an iron (Fe) and sulphur containing cofactor that includes an iron-sulphur cluster at the active site, in most of the proteins, this Fe-S cluster also contain Mo.
- ❖ As a constituent of ferredoxin-containing nitrogenase, sulphur take part in the biological nitrogen fixation (BNF) and other electron transfer reactions.
- ❖ Several biologically active compound like vitamins - thiamine and biotin, lipoic acid, acetyl co-enzyme A and glutathione contain S as an essentials part.
- ❖ It is involved in the synthesis of glucosides in mustard oil.
- ❖ It plays a major role in improving the oil quality in oilseed crops.
- ❖ Although not a constituent, sulphur is required for the synthesis of chlorophyll.
- ❖ It increases root growth.
- ❖ Sulphur stimulates seed formation.

Sulphur deficiency Symptoms

The main symptom of sulphur nutrient deficiency is yellowing of younger leaves may be due to low chlorophyll production. Eventually plant growth will be reduced.

Groundnut

- Yellowing of plants with stunted growth can be seen
- Delay in maturity.
- Severe sulphur deficiency leads the entire plant turn to yellow.

Sunflower

- Yellowing can be seen from base of the plant to top.
- Slightly plant growth is reduced.

- The size of capitulum is severely restricted.
- Maturity of flowers is delayed.

Sesame

- Stunted growth of plant is observed, leaves are smaller and fully emerged leaves first turn pale and then golden yellow.
- Number of flowers and pods are reduced so yellow will be less.

Mustard

- Yellowing is younger leaves. Chlorosis of leaf margins, development of purple pigmentation.
- In ward curling of young leaf lamina giving rise to a cupped appearance later in severe conditions withering can be observed.

Canola

- Younger leaves are lime-green, often with interveinal chlorotic mottles and pale leaf margins.
- Leaves are cupped or roll inwards and become thickened and crisp and brittle.

Table : Percentage of deficient sulphur samples in different districts of states collected by ICAR (TSI 2020)

Punjab	
Over 40%	Amritsar, Hoshiarpur, Ludhiana and Ropar
20% - 40%	Sangrur and Kapurthala
Less than 20%	Ferozepur, Faridkot, Bathinda and Patiala
Bihar and Jharkhand	
Over 40%	Laxmipur, Navada, Ranchi and Singhbhum
20% - 40%	Samastipur, Gopalganj, Gaya, Patna, Darbhanga, Nalanda, Aurangabad, W. Champaran, Bhojpur, Palamau, Dumka and Rohtas
Less than 20%	Muzaffarpur, Bhagalpur, Jehanabad and Munger
Madhya Pradesh and Chhatisgarh	
Over 40%	Dewas, Ujjain, Mandsaur, Dhar, Morena, Vidisha, Rajnandgaon, Gwalior, Sehore, Indore, Sidhi, Chhindwara, Balaghat, Seoni and Khandwa.
20% - 40%	Bhopal, Jabalpur, Bhind, Guna, Satna, Sagar, Ratlam and Raipur
Less than 20%	Narsinghpur, Bilaspur, Durg, Mandla and Betul
Rajasthan	
Over 40%	Banswara, Dholpur, Chittorgarh
20% - 40%	Bharatpur, Sriganganagar, Bikaner, Udaipur, Jhunjhunu and Kota
Less than 20%	Jaipur, Jodhpur and Nagaur
Uttar Pradesh and Uttaranchal	
Over 40%	Lucknow, Banda, Ballia, Hardoi, Varanasi, Pratapgarh, Faizabad, Kanpur, Gazipur, Mirzapur
20% - 40%	Allahabad, Sitapur, Hamirpur, Jhansi, Lalitpur, Bulandshahr, Agra, Fatehabad, Firozabad, Mainpuri, Aligarh, Moradabad
Less than 20%	Jalaun, Farukhabad, Nainital, Almora, Gaziabad, Meerut

Haryana	
Over 40%	Ambala, Faridabad and Hisar
20% - 40%	Gurgaon, Jind, Panipat, Sonapat, Mohindergarh, Bhiwani and Kaithal
Less than 20%	Rohtak, Reawari, Sirsa and Kurukshetra

Causes of Sulphur Deficiency in Soil : Availability of sulphur in soils is strongly influenced by the soil organic moiety and other soils properties. A few of these are discussed as follows-

Soil texture: Sandy soils owing to its low organic matter content and low water holding capacity sulphate-S is leached with irrigation water to deeper soil layers. So this type of soil is found to be deficient in sulphur.

Soil organic matter content: Organic matter is the major reservoir for S as a higher fraction of S is associated with organic matter. However, the availability of S depends upon the mineralization-immobilization turnover (MIT) of the soils rather than the organic matter content of the soil.

Soil temperature: The conversion of various forms of S to the sulphate-S form is a microbial process which depends upon the soil temperature. Temperature in the mesophilic range (25-35⁰C) is beneficial while low soil temperatures slow this process.

Drainage: Microbial conversion of organic S to sulphate-S requires free oxygen and aeration. The process slows down when the soil is saturated with water.

How to overcome Sulphur Deficiency?

- The Sulphur requirements of oilseeds can be overcome by supplying Sulphur containing fertilizers.
- Sulphur nutrient may be supplemented to plants in both soil application as basal, top dressing, fertigation and also by foliar application.
- Commercially available sulphur containing product are below.

Source of Sulphur Fertilizer

A. Soil application grade

1. **Gypsum:** Gypsum contain 18.6% sulphur. Gypsum of calcium sulfate dehydrate ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$).

It is slightly soluble in water and widely used as a fertilizer (Soil ameliorant).

2. **Ferrous Sulphate:** 18.6 % Sulphur
3. **Magnesium Sulphate:** 21.2 % Sulphur
4. **Zinc Sulphate:** 17.8 % Sulphur
5. **Copper Sulphate:** 12.8 % Sulphur
6. **Single Super Phosphate (SSP):** 11 % Sulphur
7. **Ammonium Phosphate:** 13 % Sulphur
8. **Bentomite sulphur:** (80%)

B. Spray and fertigation grade

1. Sulphur 80 % WP, WG and WDG formulation
2. Liquid Sulphur: It contains 20 % Sulphur. Usually comes in liquid form so it can be used for foliar application.

Method of Application

Soil application: Basal soil application of S is superior and corrects its deficiency more efficiently than foliar sprays. Gypsum was found to be most widely used for soil application.

Foliar application: Foliar application refers to the spraying fertilizer solution on foliage (Leaves) of growing plants. Normally, these solutions are prepared in low concentration (2-3%) either to supply anyone plant nutrient or a combination of nutrient.

Conclusion

In India, the productivity of oilseeds remains low due to the low consumption of S fertilizers and a large propagation deficit. The sulphur requirements of oilseeds can be met by a number of S-containing materials, such as gypsum, phosphor gypsum, S elements, pyrite and iron sulphate. It can also be added with fertilizers containing primary nutrients such as ammonium sulphate, SSP, potassium sulphate, etc.

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