Sulphur Nutrition in Indian Agriculture: Importance, Deficiency and Management

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ABSTRACT

Sulphur is gradually being identified as the fourth element along with nitrogen, phosphorus, and potassium in Indian farming. The large application of high analysis fertilizer, reduced application of organic manures, and increase in crop intensification have resulted in the deficiency of sulphur, which is an area of grave concern regarding soil fertility resources covering the whole agro-climatic region of the Indian subcontinent. The primary topics that this paper would cover include the application of sulphur in crops, the extent of sulphur deficiency in Indian soils, the effect on crop productivity, and optimal use.

INTRODUCTION

Sulphur has tremendous applications in plant growth as an integral component of essential amino acids (cysteine, methionine), proteins, vitamins, co-factors, and chlorophyll. However, in the context of India, the requirement for sulphur nutrition has recently been brought into the limelight as there has been an increased area under oil crops and pulses, besides intensive cropping. However, the requirement and utilization of sulphur have been highlighted by Tandon (1991), where sulphur has been referred to as the "fourth major nutrient" since sulphur becomes an inadequate factor in the nutrition pattern of the Indian agriclímatic conditions. There has been an increasing trend of sulphur deficiency, being an area related to soil fertility.

Status of Sulphur in Indian Soils

Large-scale studies conducted on a country-wide scale regarding soil fertility in diverse regions in Asia, namely India, have revealed that 40-55% of soils used for cultivating crops lack available sulfur in their constitution. The extent of the scarcity was found in light-textured alluvial soils, red soils, and irrigated regions where intensive crop production is carried out. States with deficient sulfur in this area include Orissa, West Bengal, Uttar Pradesh, Madhya Pradesh, Rajasthan, Karnataka, and Tamil Nadu. According to Biswas *et al*. (2004), yield-based subtraction of sulfur without proper recharge led to accelerated mining.

Causes of Sulphur Deficiency

The major factors responsible for the increased deficiency of sulphur in Indian soil are:

- Use of Sulphur-containing fertilizers, Single Superphosphate, and Ammonium Sulphate replaced by Urea
- Usage of Farm Yard Manure/Organic Reserves is decreasing
- Increased intensity of cropping, intensity of nutrient removals
- Leaching losses during high rainfall conditions
- Low organic carbon content found in Indian soils

Importance of Sulphur to Growth and Yield in Plants

Sulphur is an important compound in enzyme actions, nitrogen metabolism, as well as in the process of protein formation. It has been made evident in various studies that sulphur influences the yield significantly. Tiwari & Gupta (2006) emphasized an increase in crop yield of 15-30% in mustard, groundnut, and soybean, as well as an increase in the oil content of oil crops and the protein content of pulses, due to the use of sulphur.

Variety-Wise Sensitivity to Sulphur Addition

Oilseeds such as mustard, groundnut, sunflower, and soybean have maximum responsiveness to sulphur fertilization; this is attributed to the high sulphur requirement. Legumes such as chickpea, pigeonpea, and lentil have responsiveness to sulphur fertilization; this is attributed to sulphur deficiency in the soil. Cereals such as rice, wheat, and others have moderate responsiveness to sulphur fertilization; this is attributed to enhanced efficiency of nitrogen utilization. There exist various Long-Term Crop Nitrogen Studies scattered across the country; they indicate high yields attributed to balanced fertilization inputs such as sulphur.

Source of Sulphur Fertilizers

Single superphosphate, gypsum, ammonium sulphate, elemental sulphur, and sulphur-coated fertilizers are the common sulphur sources used in Indian agriculture. Single superphosphate remains an important fertilizer for supplying both phosphorus and sulphur. Gypsum is very extensively used in acidic and sodic soils, while elemental sulphur is suitable for alkaline calcareous soils because of its acidifying nature.

Integrated Sulphur Management

Integrated nutrient management through the combined use of inorganic sulphur fertilizers along with organic sources like farmyard manure, compost, green manures, and crop residues is essential to maintain sulphur availability. Sulphur supply from mineralization of organic matter is substantial in soils. Recommendations on sulphur based on soil testing are indispensable for efficient use of fertilizers besides reducing nutrient losses.

Role of Soil Micro-Organisms in Sulfur Cycle

Soil microorganisms play a key role in sulphur transformation and availability in soil. The availability of sulphur to plants is affected by the microbial processes of organic sulphur mineralization, oxidation of elementary sulphur, and reduction of sulphate. These processes are linked to the sulphur cycle and carbon and nitrogen cycles to highlight the key role that microorganisms play in the dynamics of soil nutrients (Liu *et al*., 2021).

It has also been made clear in recent studies that sulphur amendment has the potential to influence the microbial composition in the soil, and this increases the health of the soil. These are some of the advantages that result from reduced microbial activities in soils attributed to good sulphur nutrition (Zhou *et al*., 2025).

Sulphur and Soil Health

The indirect role of sulfur in soil improvement involves enhancing microbial activity. Ideal concentrations of sulfur in soils provide aggregation, nutrient cycling, and productivity. The role of fertilizer while rebuilding soil fertility in degraded and intensively exploited soils involves participation in nutrient management schemes.

Economic & Environmental Advantages

Sulphur fertilizer applications in soil are one of the most cost-effective fertility management methods in Indian agriculture. Biswas and Tewatia (1991) have shown that there is a substantial benefit-cost ratio when sulphur fertilizer is used in oilseed crop systems. Adequate nutrition of soil sulphur improves sulphur use Conclusion with Recommendations.

Follow-up Strategies and Recommendations

For a better management of sulphur in India, awareness, inclusion in soil health card schemes, promotion of sulphur-based fertilizer use, and regional research work are needed in the country. Theories related to government policies that provide balanced fertilizer use principles to achieve proper nutrients management for sustaining crop growth and farm revenues are key strategies in this concern.

CONCLUSION

Sulphur deficiency is found to be a silent limiting factor in agriculture in India. Sulphur deficiency needs a critical intervention in the form of appropriate management of fertility balance, a combination of organic and inorganic fertility, and soil test-based management to maintain the fertility and health of the soil.

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