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ROLE OF SULFUR IN AGRICULTURAL AND HORTICULTURAL CROPS

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ARTICLE NO- 37

Abstract:

Sulphur (S) is an essential element in forming proteins, enzymes, vitamins, and chlorophyll in plants. It is crucial in nodule development and efficient nitrogen fixation in legumes. Sulfur is essential for plant growth and functioning. Sulfate taken up by the roots is the primary sulfur source for growth, but additionally plants are able to utilize absorbed sulfur gases by the shoot. Prior to its assimilation sulfur needs to be reduced and cysteine is the primary precursor or sulfur donor for other plant sulfur metabolites. Sulfur is of great significance for the structure of proteins and functioning of enzymes and it plays an important role in the defense of plants against stresses and pests. Sulfur metabolites such as glutathione provide protection of plants against oxidative stress, heavy metals and xenobiotics. Secondary sulfur compounds (viz. glucosinolates, γ-glutamyl peptides and alliins), phytoalexins, sulfur-rich proteins (thionins), localized deposition of elemental sulfur and the release of volatile sulfur compounds may provide resistance against pathogens and herbivory. In agricultural ecosystems, the occurrence of sulfur deficiency of soils can easily be corrected by the application of sulfur fertilizers, which additionally prevents negative environmental side effects such as leakage of nitrate to drainage water. Oil crops, legumes, forages and some vegetable crops require sulfur in considerable amounts.

Key words: Sulphur, functions and deficiency symptoms, Corrective measures

Introduction: Sulfur acts as a soil conditioner and helps reduce the sodium content of soils. Sulfur in plants is a component of some vitamins and is important in helping give flavor to

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mustard, onions and garlic, Sulfur assists in seed oil production. The role of sulfur as a soil conditioner to reduce sodium requires per acre. Sulfur deficiencies in soil are rare, but do tend to occur where fertilizer applications are routine and soils do not percolate adequately. Sulphur is required for many growth functions in plants – like nitrogen it is principally an essential constituent of protein. There is therefore a close relationship between the quantities of nitrogen and sulphur in crops, with most taking up about 1kg of sulphur (2.5kg SO_3) for every 12kg of nitrogen. Brassica crops, such as oilseed rape, cabbage and kale, require much more sulphate. They need extra sulphur for the production of glucosinolates, which are used within the plants as a defense mechanism.

In the plant nitrogen and sulphur are both essential building blocks for proteins. Sulphur deficiency will severely reduce the efficient use of nitrogen and limit protein synthesis. Since industrialization a lot of soil sulphur came from sulphur dioxide in air pollution (from burning fossil fuels). Declining emissions are reducing this source of atmospheric sulphur making balanced fertilizer application even more important. Sulphur can only be taken up by plants from the soil solution as sulphate. As with readily-available nitrate, it can be liable to loss through leaching. Spring application of sulphate fertilizer is therefore recommended so that the plant can take it up during the period of active growth, as with nitrate. Sulphur is required together with nitrogen for the formation of proteins and uptake timings are similar.

Sulfur in Soil:

Most of the sulfur in soils is found soil in organic matter. However, it is not available to plants in this form. In order to become available to plants, the sulfur must be first released from the organic matter and go through mineralization process. The mineralization process is a result of microbial activity. In this process sulfur is converted to the sulfate form (SO_4^{-2}), which is readily available to plants. The process is affected by the C/S ratio, temperature and moisture. Immobilization of sulfur is the opposite process in which available sulfate is converted back into the organic form. Due to its negative charge, the sulfate inorganic form (SO_4^{-2}) is mobile in soils and behaves like nitrate in the soil.

Sulfur Deficiency Symptoms:

Sulfur is immobile in plants and does not readily translocated from older leaves to young leaves. Therefore, sulfur deficiency first appears on younger leaves. Plants that are not

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able to intake enough sulfur will exhibit yellowing of leaves that seems remarkably similar to nitrogen deficiency. With sulfur depletion, problems tend to show up on the younger leaves first followed by the older leaves. In plants depleted of nitrogen, the older leaves at the bottom are first affected, moving upwards. Deposits of gypsum in the soil strata can capture sulfur and older plants with long roots may recover once they reach this level of soil.

The role of sulfur as a nutrient is most evident on mustard crops, which will exhibit scarcity symptoms early in development. Soil tests are not reliable and most professional growers rely on plant tissue tests to verify deficiencies in soil. Sulfur deficiencies are more likely in sandy soils with low organic matter (less than 2%) and under high rainfall conditions. However, even in high organic matter soils, often, the breakdown of the organic matter and the mineralization process are not rapid enough to meet the sulfur requirement of the crop. When this occurs, fertilizers or amendments containing sulfur have to be applied.

Sulfur deficiency symptoms show up as light green to yellowish color. Deficient plants are small and their growth is retarded. Symptoms may vary between plant species. For example, in corn, sulfur deficiency shows up as interveinal chlorosis; in wheat, the whole plant becomes pale while the younger leaves are more chlorotic; in potatoes, spotting of leaves might occur.

Sulphur deficiency causes yellowing (**Chlorosis**) of leaves. Young leaves are affected first.

- Leaf tips are characteristically bent downwards. The leaf margins and tips roll inwards. (Example: Tomato, Tobacco and Tea)
- Marked decrease in leaf size, general paling with red or purple pigmentation are general symptoms.
- Necrosis of young leaf tips develop and internodes are shortened.
- Apical growth is inhibited and lateral buds develop prematurely
- Fruit formation is suppressed.
- Sclerenchyma, xylem and collenchyma formation gets increased and hence the stem becomes unusually thick due to S deficiency.
- The **Tea Yellow disease** is caused in tea plants growing in sulphur deficient soils. Sulphur deficiency is known as "**tea yellows**". Leaves of S deficient bushes turn yellow are reduced in size, the internodes are short and the entire plant appears shrunken. Under severe deficiency.

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leaves may curl up and their edges and tips turn brown. Axial buds produce dwarf yellow leaves.

Corrective Measures: Common fertilizers used for supplying nitrogen and phosphorus contain appreciable amount of sulphur sufficient to meet the crop requirement. In case of severe deficiency, gypsum is added to the soil @ 500Kg/ha.

Role of sulfur in plants:

Plants mainly absorb S in the form of SO_4^{-2}.

Sulfur has various functions in plants. Some major roles are:

- Sulphur is a constituent of amino acids, cystine, cysteine, and Methionine and the building blocks of proteins.
- The characteristic odour of cuciferous plants, onion and garlic is due to the presence of sulphur as a constituent of volatile oils. Essential in the synthesis of oils, especially in oil crops.
- Several other biological active compounds like vitamins (Thiamine and biotin), lipoic acid, acetyl co-enzyme A, ferredoxin and glutathione contain sulphur as an essential part.
- The active adenosine-5-phospho sulphate (APS) is an important sulphate donor which is involved in the synthesis of glycosides in mustard oil. Being involved in the activation of number of enzymes, participating in the dark reactions of photosynthesis, sulphur is involved in carbohydrate metabolism of the plants.
- Sulfur is essential for chlorophyll formation. It is a major constituent of one of the enzymes required for the formation of the chlorophyll molecule.
- Active in the metabolism of nitrogen.

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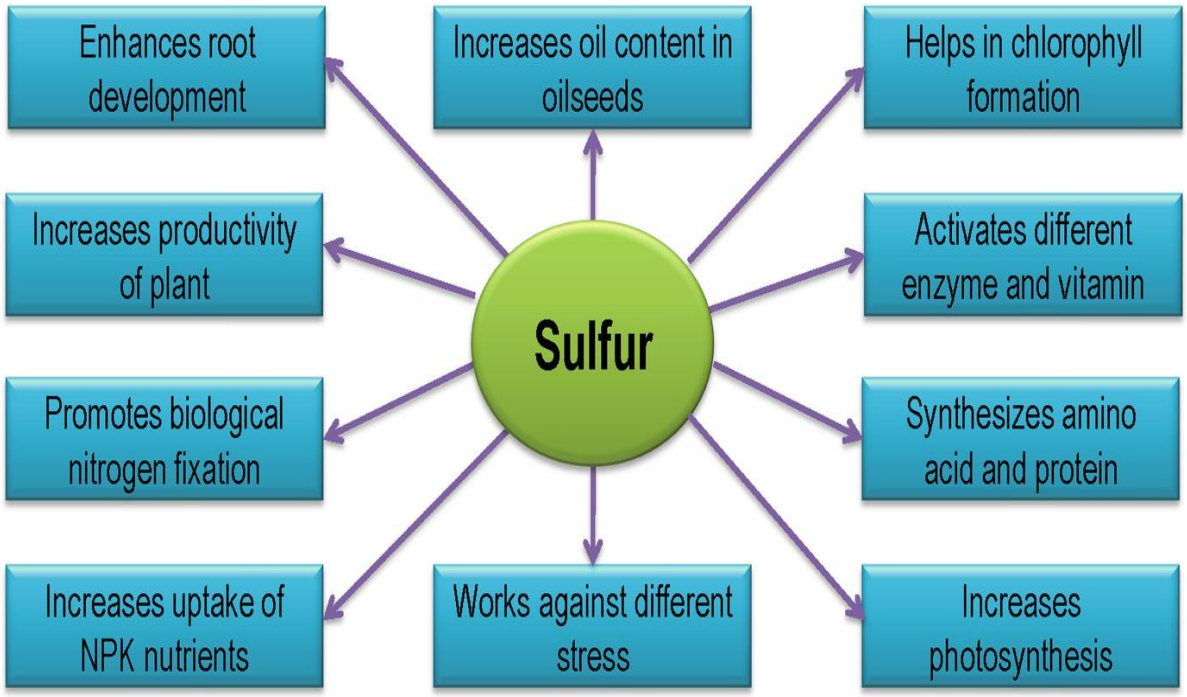

Summary

Sulfur (S) deficiency affects chlorophyll production, protein synthesis, and plant function and structure. It occurs in soils containing allophane, soils with low organic matter status, highly weathered soils containing large amounts of Iron (Fe) oxides, and sandy soils. Sulphur deficiency symptoms in many ways resemble those of nitrogen - that is, the leaves become pale-yellow or light-green. Unlike nitrogen, sulphur -deficiency symptoms appear first on the younger leaves, and persist even after nitrogen application. Plants deficient in sulphur are small and spindly with short and slender stalks, their growth is retarded, maturity in cereals is delayed, nodulation in legumes may be poor and nitrogen-fixation reduced, fruits often do not mature fully and remain light-green in color, forages contain an undesirably wide N:S ratio and thus have lower nutritive value. When sulphur deficiency symptoms have been confirmed, soil application through a material containing readily available sulphur should be applied. Plants in natural ecosystems generally have an adequate sulfur supply, which partly originates from atmospheric sulfur inputs. Although it is considered a secondary nutrient, it is now becoming recognized as the 'fourth macronutrient', along with nitrogen, phosphorus and potassium.