Effects of Sulphur Deficiency on the Growth and Metabolism of the Soy Bean

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Soy bean plants were grown in washed quartz sand in the greenhouse in the springs of 1933 and 1934. Half of the plants were given a complete nutrient solution and half a solution in which magnesium chloride was substituted for magnesium sulphate. In order to keep the plants from blooming before marked symptoms of sulphur deficiency developed, the natural day length was increased to about 16 hours by the use of electric lights.

The main symptoms of sulphur deficiency in the soy bean were: the yellow-green color of the leaves, the smaller leaves, and the thinner stems. The tops were stunted more than the roots. The upper leaves became yellow first. These symptoms are similar to those of the deficiency of other elements, for example, nitrogen, phosphorus, and calcium. This is perhaps to be expected, especially as regards the effect on color, since the deficiency of sulphur and the above elements except nitrogen causes a low reducase content of the plants, and so nitrates cannot be used, although they are present in the nutrient solution. Under these conditions the plant is naturally chlorotic, since nitrogen is necessary for the synthesis of chlorophyll. Also, sulphur may have an effect on the color of the plant due to the fact that it is a constituent of the proteins of the chloroplast, though it is not found in chlorophyll itself. It needs to be kept in mind too that calcium interferes with the absorption of nitrates. The stems of the minus-sulphur plants elongated remarkably and were almost as tall as the stems of the plus-sulphur plants. The main effects of sulphur deficiency on the chemical composition of the plant were that carbohydrates, nitrates, and soluble organic nitrogen accumulated in the minus-sulphur plants. However, this was not true of all forms of carbohydrates. Starch was higher in the sulphur-deficient plants, but the plus-sulphur plants had a higher content of sugar. Carbohydrates and nitrates no doubt accumulated in the minus-sulphur plants, because the synthesis of amino acids and other organic nitrogenous material was restricted by the low reducase content of the plants. The higher percentage of the soluble organic nitrogenous material in the sulphur-deficient plants was probably due mainly to proteolysis, the hydrolysis of the proteins. As a rule, in a plant which is poorly vegetative because of the deficiency of an essential element, the proteins are not broken down unless the plant is put in continuous darkness. The minus-sulphur plants were able to carry on this process in the light, and it was their ability to do this that accounts for the stem elongation of these plants, which was mentioned above.

Summarizing, the main symptoms of sulphur deficiency in the soy bean are: the yellow-green color of the leaves, the smaller leaflets, and the thinner stems. The tops are stunted more than the roots. The upper leaves become yellow first. These symptoms are probably due both to the lack of sulphur and to poor nitrate assimilation, which results from the low reducase content of the minus-sulphur plants. Because of poor nitrate assimilation, starch and nitrates pile up in the sulphur-deficient plants and the accumulation of starch is correlated with harder stems. The minus-sulphur plants are high in the soluble forms of organic nitrogen. This is due mainly to proteolysis and is important in the stem elongation of these plants.