

# Effect of sulphur upon plant response to phosphate

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## SUMMARY

Native sulphur is supplemented by variable additions from rain-water, irrigation water, fertilizers and insecticides. Sulphur deficiency, however, still exists in many parts of the world and could be overcome for high yields by mixing together elemental and rock phosphate, applying sulphur containing fertilizers, growing clover and grass in sulphur-deficient soils, by presence of soluble salts in fertilizers, applying ammonium sulphate under limed condition and ammonium sulphate with triple superphosphate.

## INTRODUCTION

In the surface soil, sulphur is predominantly in the organic fraction and this element varies from less than 100 ppm to several tenths percent. This native sulphur is supplemented by variable addition from rainwater (5- to 45-kg S/ha per year), irrigation water (3-1,849 kg/ha flood water), fertilizer (0.02-% sulphur in ammonium nitrate, 7.8-13.3% in ordinary superphosphate and 0.05-2.6% in concentrated superphosphate) and insecticides (56-67 kg/ha).

## SULPHUR DEFICIENCY

But, in spite of amendments, sulphur-deficient areas are widespread in non-irrigated soils in many parts of the world.

In humid regions sulphur deficiency may arise due mainly to leaching, erosion and crop removal. Amount removed by crops varied with kinds. Crops those require large amount of sulphur are cabbage, cauliflower, turnip, onions and asparagus. They require

approximately 45 kg S/ha. Crops requiring intermediate amount are legumes, cotton and tobacco, while those requiring small amounts are small grains, grasses and corn.

### **STEPS TO OVERCOME DEFICIENCY**

Sulphur carriers are added to the soil to overcome this sulphur deficiency. Its presence in the fertilizer, besides increasing sulphur availability to plants, may influence phosphorus availability. This influence may be related to its effect on the solution of phosphorus compounds, and the nature of the reaction products formed in the soil or to the stimulation of plant growth due to its presence (16).

### **Rock phosphate**

Considerable work has been done in the past in which elemental sulphur and rock phosphate have been mixed and applied to the soil. The idea is that sulphur upon oxidation in the soil will react with the phosphate rock thereby increasing availability of phosphorus in the rock phosphate. Attoe and his coworkers in Wisconsin have developed a material by stirring finely divided rock phosphate into molten sulphur, cooling the mixture and then grinding it to some suitable particle size from a series of experiments on the use of sulphur for increasing availability of phosphorus in rock phosphate (20). Kittams (12) stated that application of rock phosphate and sulphur in the ratio of 2:1 to unlimed silt loam of pH 6.6 increased phosphate uptake up to 121 percent as compared to 54 percent for rock phosphate; in limed silt the increases were 29 percent for the mixture, and 7 percent for rock phosphate. Yield of lucerne was also increased.

Ahmed et al. (1) reported from their experiments that the use of sulphur on the uptake of phosphate by the rice plant grown on a clay loam soil with pH 6.7 increased gradually with increasing rate of sulphur (phosphate sulphur ratio from 20:1 to 2.5:1). The yield also increased similarly.

### **Sulphur containing fertilizers**

Khun and Mangel (13) working with sulphur deficient calcareous soils and acid sands concluded that sulphur containing fertilizers

increases phosphorus uptake as well as yields of red clover, mustard, sunflower and bean.

#### **Clover and grass**

Neller and Bartlett (15) observed that growth and phosphorus percentage of clover and grass grown on sulphur deficient soil increased, where sulphur had been added annually at 144 kg/ha to treatments that received rock phosphate at 336 kg/ha as compared to rock phosphate only at 678 kg P<sub>2</sub>O<sub>5</sub>/ha. Yields also significantly increased. In greenhouse studies where sulphur was used at higher rates, availability of the rock phosphate was increased. Soil samples taken at the end of the experiment contained significantly more soluble phosphate in the surface 7.5 cm than in the 7.5-15.0 cm. From grass and clover test on a virgin Leon fine sand near Gainesville, Florida, Bledsoe and Blaser (1947) stated of significantly higher yields when sulphur was added to fertilizers (basic slag, rock phosphate and phosphoric acid) as phosphate sources.

#### **Soluble salts**

The presence of soluble salts in the fertilizer along with the phosphate material exert some influence on phosphate availability. This increase may be accounted for an increased stimulation of the plant due to their presence or by the influence of these salts have on the availability of phosphate materials. Starostka and Hill (19) postulated that since the phosphate in mixed fertilizers was often more available to plants than di-calcium phosphate alone, the presence of other fertilizer salts may influence the availability of dicalcium phosphate. They found ammonium sulphate increasing the solubility considerably and salts of ammonium sulphate nitrate increasing the solubility slightly. Robertson, et al. (18) found an increasing uptake of fertilizer phosphate when ammonium sulphate was added as the starter fertilizer.

#### **Ammonium sulphate under limed condition**

Lutz and Rich (14) observed that under limed conditions ammonium sulphate enhanced phosphate uptake by zero percentage. They found that in most cases the presence of sulphur carriers increased the availability of applied phosphate plants. Bouldin

et al. (5) studied the influence of associated salts with monocalcium phosphate on the nature of the reactions that occur between these mixtures and the soil. The range in percentage of phosphate that remained at the granular site was from 92 percent when monocalcium phosphate was mixed with  $\text{CaCO}_2$  to 2 percent when monocalcium phosphate was mixed with ammonium sulphate. Bouldin and Sample (4) also demonstrated the influence of associated salts on the availability of concentrated superphosphate in a greenhouse and laboratory experiment. The order of effectiveness of salts was generally  $(\text{NH}_4)_2\text{SO}_4$   $\text{NH}_4\text{NO}_3$   $\text{NH}_4\text{Cl}$ .

In nearly every instance good agreement was found between the effectiveness of salt on phosphate availability and the phosphate availability and the phosphate uptake by plants. Bouldin and Sample (4) concluded that the influence of associated salts on phosphate availability from concentrated superphosphate was the result of the chemical effect of the reaction products in the soil and not due to any effect that associated salt had on physiological uptake of phosphate by plants.

#### **Mixed ammonium sulphate and triple superphosphate**

Islam and Rahman (8) working with rice plants at waterlogged condition observed that the application of ammonium sulphate along with triple superphosphate increased the phosphate availability significantly. The increase was also gradual with rates of applications of ammonium sulphate. The increased availability was also reflected by higher assimilation of phosphate by rice plants. Similar results were also obtained in upland conditions where wheat plants were grown (8).

### **CONCLUSION**

The current trend towards the use of high analysis fertilizers that contain little carrier sulphate has undoubtedly contributed to the development and discovery of new areas of deficiency. Also, there can be little question that many instances of mild sulphur deficiency now go unrecognised. Exploratory tissue analysis, parti-

cularly of plants with high sulphur deficiency is suspected (6). The next step lies in the choice of the form of sulphur. Extensive use has been made of both elemental sulphur and gypsum as sources of sulphur. Between the two, price will remain as one of the deciding considerations. If elemental sulphur is indicated as most economical, its full availability will not be realized in less than four months after it is incorporated into the soil. Elemental sulphur will, with its oxidation, increase the ability of the soil. Under circumstances, this increase may be desirable, but calcium sulphate should be preferred because it contains both sulphur and calcium.

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