STUDIES IN SOIL AND PLANT MANGANESE

IV. SUPERPHOSPHATE FERTILIZATION AND MANGANESE CONTENT OF YOUNG OAT PLANTS

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INTRODUCTION

The uptake of manganese by plants is not determined by the total amount of the element in the soil but by its availability to the particular species or even to the particular variety of the plant in question. Natural soils are very complex and many of the factors involved in their composition and properties influence the availability of manganese. The best known factor is soil reaction. An increase in the acidity of a soil increases the availability of its manganese: conversely, a decrease in the acidity of a soil – one effect produced by liming – reduces manganese availability; perhaps so much so that the deficiency disease “grey speck” of oats has often been caused by over-liming. In the extensive literature on the subject there are descriptions of the influence of other nutrients, both macro- and micro-, on manganese availability. Often the interrelationships of the various nutrients with each other and with experimental conditions are far from simple. What appear to be conflicting results may, in fact, reflect the slightly different conditions employed by different workers.

The present picture of the effect of phosphate fertilization on the manganese content of the crop is an example. Fertilization with superphosphate has been reported as causing an increase in manganese uptake by orange trees (Reuther, Gardner, Smith, and Roy) and as having no effect

with forage crops (Burriel-Marti and Suarez y Suarez). Beeson, Grey, and Hamner reported a decrease in manganese content of soybean. Unfortunately, they did not name their fertilizer, stating only that “40 pounds of P₂O₅” were used. Morris reported increases for lespedeza and decreases for sweet clover. Steckel, Bertramson, and Ohlrogge found that the availability of manganese (as sulphate) to oats and soybeans was increased by placement with superphosphate and suggested that this was brought about by the precipitation of manganous phosphate in a local environment of higher hydrogen ion concentration. Similarly, better control of marsh spot in peas was reported by Rose and Dermott when manganese sulphate was given with superphosphate. They found that with cereals superphosphate alone appeared to aggravate manganese deficiency. Larsen found that heavy applications of mono-calcium phosphate counteracted manganese deficiency in barley and gave increased yields; the manganese content of the crop was not recorded. Bingham, Martin, and Chastain, also Bingham and Garber, confirmed the findings of Reuther et al. that heavy applications of superphosphate increased the manganese uptake by citrus trees. Lamb found that heavy dressings of superphosphate depressed the manganese content of tomatoes affected by manganese toxicity.

Spencer suggested that the increase in manganese availability following heavy applications of superphosphate ought to be attributed to an increase in soil acidity rather than to a genuine “phosphate” effect. This view would tend to find support in the results of Snider who found that the manganese content of grasses was increased by manuring with superphosphate but not with rock phosphate. The effects of lime and superphosphate on the manganese content of lettuce plots were attributed by Messing primarily to changes in soil pH.

The outstanding problem to be solved concerns the role of superphosphate – whether it facilitates manganese uptake directly, or whether it operates indirectly through acidification of the soil. Extensive sets of data, representing one year’s results from eight experimental centres forming part of the long term field project in progress at the West of Scotland College, were available to us and have been used in this paper to examine this question. These results were obtained from experimental centres widely distributed throughout the West of Scotland, and chosen to include such a range of soil types and variety of situations that most of the typical farm environments in the area would be represented. The data on manganese content of oats and soil pH associated with the fertilizer applications are thus more numerous and represent more diversified conditions than have (to our knowledge) been reported for any single crop.