Properties of Coated Fertilizer Materials

CONTROLLED AVAILABILITY FERTILIZERS

PART II OF A FIVE-PART SERIES

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The rate of release of highly soluble inorganic fertilizers can be controlled by enclosing the fertilizer granule in a coating membrane. Factors which affect that rate under growing conditions were studied to gain a better understanding of the mechanism involved. The rate of release remains nearly constant until about two thirds of the fertilizer has been released; thereafter the rate drops off. After the first few days or weeks the rate may increase slightly.

The thickness of the coating material regulates the rate of release. The table gives a comparison of three different membrane thicknesses in an elution study with coated potassium chloride. Initially the release rate was highest with the thinnest coat. This caused rapid exhaustion of the salt within the granule, and within a few weeks the rate of nutrient supply dropped below that observed with the thicker coatings.

POTASSIUM RELEASED FROM POTASSIUM CHLORIDE FERTILIZERS WITH COATINGS OF DIFFERENT THICKNESSES

Thickness of coating	First week %	Third week %	Sixth week %	Ninth week %
Light	58.2	8.0	3.8	1.1
Medium	46.8	10.2	4.9	1.5
Heavy	12.8	7.8	10.3	6.0

From a 10:10:10 fertilizer, the initial release of nitrogen ions, nitrate, and ammonium was more rapid than that of potassium or phosphates.

External conditions

Coated fertilizers can be used under any soil conditions of acidity or alkalinity. Two elution experiments showed no definite effect of the hydrogen-ion concentration on release rate. In general, the release curves were almost identical in solutions at pH values of 4, 6, or 8, and also in soils which ranged from very acid to very alkaline.

Raising the temperature from 10 to 20°C roughly doubled the release rate. The temperature effect was smaller between 20 and 30°C. Since the growth rate of plants is increased at higher temperatures, nutrient supply and growth rate may thus change in the same direction.

A buildup of external salt concentration has little effect on the rate of release of coated fertilizers. Apparently the solution inside a granule is saturated, and biologically tolerable salt concentrations of the external solution have little effect on the concentration difference between the two sides of the membrane.

Microbial attack was not required for release of minerals through the coating. Probably the high internal salt concentration prevents attack by micro-organisms until after most of the salts have been leached out. In one test, the rates of release from granules were even slightly lower under sterile than under non-sterile conditions. But this may have been caused by the effect on membrane permeability of the formaldehyde solution used to prevent microbial activity.

Placement of fertilizer

Leaching experiments with soil columns indicate that the yield of potassium and phosphorus is 30 to 50 per cent lower when the coated material is placed as top-dressing than when it is incorporated uniformly through the soil. However, the release curves under the two conditions are similar, and top-dressing is considered a suitable method for the application of coated materials.

Diffusion mechanism

At first look, there appear to be some discrepancies in the explanation of diffusion as a mechanism of salt release, because the temperature coefficient with coated granules is too high for a diffusion process and the rate of release by diffusion should not increase after a few days. However, the membranes do not necessarily remain rigid but may actually expand somewhat in course of time, and this expansion may be affected by temperature. Expansion would enlarge the pores of the membranes and facilitate diffusion. Visual inspection of the granules confirms such a change in the coating, because the initially jagged granules become nearly spherical after exposure to moisture.

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The above progress report is based on Research Project No. 1469.

CALIFORNIA AGRICULTURE

Progress Reports of Agricultural Research, published monthly by the University of California Division of Agricultural Sciences.

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