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STUDIES ON SLOW-RELEASE FERTILIZERS: II. A METHOD FOR EVALUATION OF NUTRIENT RELEASE RATE FROM SLOW-RELEASING FERTILIZERS

SHARON GAMBASH, MALKA KOCHBA AND YORAM AVNIMELECH[1]

A method of evaluation of nutrient release from membrane-coated slow-release fertilizers is presented. The method is based on the gravimetric measurement of water-vapor uptake by individual fertilizer granules placed in a saturated water vapor chamber.

The nutrient release from such fertilizer consists of two stages. In the first stage, water vapor infiltrates into the granule and condenses on the soluble fertilizer salt, leading to the development of pressure within the particle. The elevated pressure leads to swelling of the granule and the outward leakage of the fertilizer solution.

The method yields results characterizing both the average rate of nutrient release and the release rate distribution among the population of fertilizer granules. The results are consistent with measurements of nutrient release rates in soil-fertilizer mixtures.

A number of methods are being used to study the release rate of nutrients from slow-release fertilizers (SRFs). Oertli and Lunt (1962) used successive extraction of fertilizers with water or buffer solutions. Lunt and Oertli (1962) incubated soil-fertilizer mixtures and extracted the soil after the incubation period. Savant et al. (1982) modified this method by placing the fertilizer in a perforated bag placed in the soil. Attoe et al. (1970) tested the amount of nutrients remaining in the coated fertilizer pockets after contact with the soil. Some investigators leached soil columns and measured fertilizer elution (Patel and Sharma 1977; Lunt and Oertli 1962). Holcomb (1981) suggested a modification of this approach, using a capillary mat placed at the bottom of pots containing peat-vermiculite mixtures, to absorb the released fertilizers.

The release of nutrients from a membrane-coated SRF was described as composed of two stages (Hauke 1972): The first stage involves diffusion of water vapor molecules from the surrounding through the membrane and a resultant condensation as saturated salt solution within the granule. The second stage occurs as pressure builds up within the coated fertilizer granule, leading to either breakage of the granule or a mass flow of solution out of the now leaky membrane. This model was substantiated by recent findings in our laboratory (Kochba et al. 1990). Moreover, the water-vapor diffusion into the granule was the rate-determining process.

With these considerations, we developed a method to measure the influx of water vapor into membrane-coated SRF particles. We present the method, the experimental results, and the conclusions drawn.

MATERIALS AND METHODS

The fertilizers tested included commercially available SRFs as well as samples of new membrane-coated KNO_3 fertilizer produced by Haifa Chemicals Ltd. Individual fertilizer particles were placed on 2.8-cm-diameter filter paper discs (Whatman GFC 1) on Petri dishes. The dishes were incubated in a saturated water-vapor chamber made of a dessicator containing distilled water at its bottom. The loaded filter paper discs were weighed (±0.1 mg) at the beginning of the measurement and periodically later. A filter paper disc without a fertilizer granule was used as a blank.

The dessicators were held in a constant temperature chamber or in the laboratory. All experiments reported here were conducted at temperatures of 20 to 30°C.

The tests were done with 10 to 30 individual granules. The confidence limits (90%) for the curves describing the distributions of the nutrients release rates of the tested granule populations were determined according to the Kolmogorov-Smirnov statistical analysis (Conover 1980) and were in the range of 22 to 37%.

RESULTS

An insight into the sequence of changes occurring in the SRF particles can be obtained

[1] Faculty of Agricultural Engineering, Technion-Israel Inst. of Technology, Haifa, Israel.

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