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Influence of Water-Content of Sand on Rate of Uptake of Rubidium-86

THE relationship between nutrient absorption and the moisture content of the soil has been the object of numerous investigations. Complications arise, however, if an attempt is made to disentangle the separate processes involved. The growth of the plant itself is strongly influenced by the moisture content of the soil and the ionic equilibria between

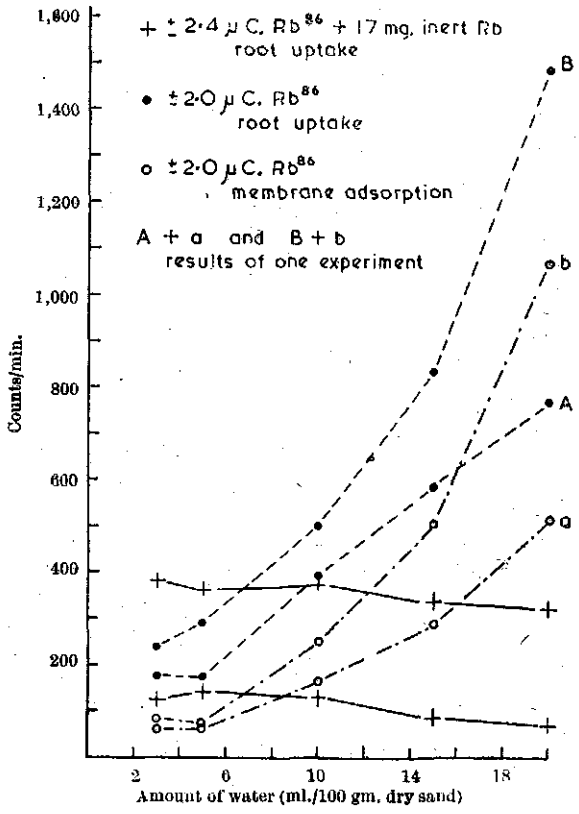

Fig. 1. Uptake of rubidium-86 by excised roots of *Vicia faba* (+ and ●); and by a cation resin membrane, 'Permaplex *C*-10' (○) from 100 gm. dry sand containing a varying amount of water (3–20 ml.)

the adsorbed ions and those in solution undergo a change. Another difficulty encountered is the fluctuation in moisture content of the soil as brought about by transpiration and watering, so that the conditions are not constant during the experiment.

The problem has recently been investigated by Dean and Gledhill[1] and by Danielson and Russell[2], who used techniques to eliminate a number of complications. Their results, however, are contradictory in some respects.

Dean and Gledhill[1] used excised rootmats of young rye seedlings that were pressed upon sand containing a fixed amount of labelled phosphate. One of their findings is that uptake can decrease with an increase of moisture content of the sand, although the reverse may also occur.

Danielson and Russell[2] made use of very young corn seedlings completely buried in the soil. They find that the ion uptake decreased rapidly with initial increases in soil moisture tension, and levelled out at higher tensions to give a curve nearly logarithmic in nature.

An attempt was made to extend our knowledge on the influence of the amount of moisture on the rate of uptake by means of a technique which eliminates complications to a great extent.

The experiments were performed with excised young root pieces of the broad bean (*Vicia faba*), which were taken from the primary laterals of plants cultivated in tap-water. A batch of twenty-five root pieces was buried in 100 gm. of washed sand to which ± 2 μc. rubidium-86 was added and a varying amount of water. In part of the experiments a varying amount of inert rubidium chloride was added besides the tracer amount. Experiments lasted about twenty-four hours and were mostly conducted at room temperature.

The results demonstrate that if only a minute amount of rubidium is present in the sand, the uptake greatly increases as the amount of water rises from 2–20 ml. If, however, a larger amount of inert rubidium is added the reverse trend is found and uptake decreases somewhat with increasing moisture content (Fig. 1).

The following explanation seems justified, and is in agreement with experience gained in work with other ions.

As long as the sand contains only a very small amount of rubidium (not exceeding ± 4 mgm./100 gm. of sand) the layer in direct contact with the root cannot furnish enough substance to meet the demands of the root. So the rate of uptake will be dependent on the number of ions able to diffuse towards the

root from more distant layers. As the moisture content of the sand rises, this diffusion is enhanced, as has been shown by Klute and Letey[3], and uptake increases. The purely physical nature of this response can be demonstrated by the fact that a cation exchange membrane reacts in exactly the same way (Fig. 1).

If, however, the amount of rubidium in the sand is higher, the moist layer surrounding the root will contain more substance than the root can absorb during the experiment. As the sand can be considered as a practically inert medium, the concentration of the rubidium in solution will vary inversely with the amount of water added. Uptake is now governed by the concentration of rubidium in solution in the pore space. So the rate of uptake diminishes somewhat with an increase in the amount of water added.

Thus the relation between moisture content of the medium and rate of uptake depends on the amount of soluble substance. At low concentrations of rubidium the rate of uptake is enhanced by increased moisture content and at higher concentrations the rate of uptake is somewhat lowered.

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[2] Danielson, R. E., and Russell, M. B., *Soil Sci. Soc. Amer. Proc.*, **21**, 3 (1957).
[3] Klute, A., and Letey, J., Ann. Meeting Amer. Soc. Agron., 1956; *Agron. Abstr.*, 4 (Nov. 1956).

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