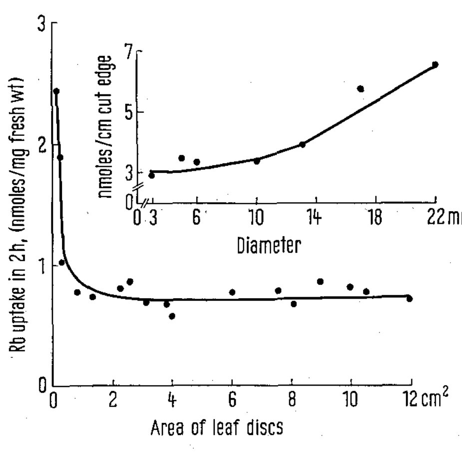
Course of Cation Accumulation by Leaf Tissue in *Phaseolus vulgaris* L.

From a classical point of view, green leaves appear to be organs whose sole function is the production of organic substances through photosynthesis in the presence of CO_2, light and water. However, during the last few decades, it has been demonstrated that absorption of inorganic and organic materials can also take place through the leaf surfaces[1,2].

Ion uptake by leaves is a multistep process[3]. Foliar applied solutes must traverse a cuticle before their absorption by leaf cells. Even stomatal penetration involves penetration through an 'inner cuticle'[4]. In view of these, the interpretation of results of studies on the mechanisms of cation absorption by intact leaves has become difficult[5], and cuticular membranes and living cells enzymically isolated from leaves have been employed to study the individual processes of cuticular penetration and cellular absorption[6–9]. Use of leaf slices and disks, however, have advantages over isolated systems, especially because of greater cellular activity[10] and comparability with excised root systems.

The absorption of ions by leaf slices does not truly relate to foliar absorption, since the penetration through the cuticular membranes enveloping the whole leaf is circumvented. Absorption of ions by cells within the disks is dependent on the rate of diffusion through the cuticle covering the surface, and that through the cut edges of the disks. If the former is predominant, it would simulate foliar absorption by an intact leaf; and when the rate of diffusion through the cut edge far exceeds cuticular diffusion, the absorption could be related to that by leaf cells and not intact leaf. The involvement of these 2 processes, viz., the diffusion through the cut edge and through the surface of the leaf disks and their implications in studies of ion uptake by excised leaf tissues, are the subject of the study.

Disks of various sizes were excised from the intercostal regions of primary leaves of 10-day-old bean plants (*Phaseolus vulgaris* L.) grown in aerated nutrient solution under artificial 12 h photoperiod. The disks were suspended in 3 l of ^{86}Rb labelled 1 mM RbCl and 0.5 mM $CaSO_4$. At the end of experimental period, the disks were washed free of adsorbed and free space Rb by suspending in unlabelled 1 mM RbCl for 15 min and then radioassayed.



The absorption of cation (Rb) as a function of the area of leaf disks. Rb absorption expressed on unit length of cut edge in disks of different diameters.

The results (Figure) show that Rb uptake increased with decreasing sizes of the disks, and remains constant for disks above 3 cm^2. In disks smaller than 2 cm^2 diffusion through the cut edge is rapid and ions thus diffused are readily available for absorption by cells. Therefore absorption by disks smaller than 2 cm^2 truly represents absorption by leaf cells. In larger disks, however, the values remain constant on unit weight basis, even though the length of cut edge of the disks increases. This is suggestive of the greater absorption by the surfaces of the leaf disks and therefore is more related to absorption by intact leaf. The results expressed on the basis of the length of cut edge also illustrate this point. Absorption per cm cut edge increases with diameter of the disks larger than 6 mm diameter (Figure). In this range of size, absorption is not related to the cut edge, but to the surface area.

The absorption of organic compounds by leaf disks (2 cm diameter) has been shown to be through the leaf surfaces, and not as a result of diffusion through the cut edge[11]. In contrast, it has been reported that ion absorption is largely restricted to the cut edge surfaces in leaf disks of *Atriplex*[12] and corn[13]. Physiological and structural differences in the plant species, like the thickness of the cuticle and the intercellular spaces might be responsible for the slow absorption by cells within. It has been shown that the minor veins are 13 times as extensive as the major veins in sugar-beet leaf[14] and these may affect the transport of ions in the leaf.

When ion absorption is measured under 500 ft-c light, the contribution of the leaf surface and the cut edge towards the absorption by leaf cells is almost equal in disks of 2.2. cm diameter. The triggering action of light on ion absorption[3] is perhaps responsible for larger diffusion through the cut edge in large disks.

Résumé. On a suivi l'absorption du cation dans les disques de feuille de différentes grandeurs. Le taux d'absorption par les cellules dans les disques est régi par le taux de diffusion à travers la cuticule à la surface et à travers la circonférence de section où sont exposés la cellule et l'espace intercellulaire. La lumière augmente la diffusion ainsi que l'absorption des ions.

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[1] J. A. SARGENT, A. Rev. Pl. Physiol. *16*, 1 (1965).
[2] S. H. WITTWER and F. G. TEUBNER, A. Rev. Pl. Physiol. *10*, 13 (1959).
[3] S. KANNAN and S. H. WITTWER, Naturwissenschaften *54*, 373 (1967).
[4] W. FRANKE, A. Rev. Pl. Physiol. *18*, 281 (1967).
[5] W. H. JYUNG and S. H. WITTWER, J. Am. Bot. *51*, 437 (1964).
[6] S. KANNAN, Pl. Physiol., Lancaster *44*, 517 (1969).
[7] S. KANNAN, Naturwissenschaften, *56*, 572 (1969).
[8] S. KANNAN and S. H. WITTWER, Physiologia Pl. *20*, 911 (1967).
[9] S. KANNAN, Pl. Physiol., Lancaster *44*, 1457 (1969).
[10] W. H. JYUNG, S. H. WITTWER and M. J. BUKOVAC, Pl. Physiol., Lancaster *40*, 410 (1965).
[11] B. PARTHIER, B. MALAVIYA and K. MOTHES, Pl. Cell Physiol. *5*, 401 (1964).
[12] C. B. OSMOND, Aust. J. biol. Sci. *21*, 1119 (1968).
[13] R. C. SMITH and E. EPSTEIN, Pl. Physiol., Lancaster *39*, 338 (1964).
[14] D. R. GEIGER and D. A. CATALDO, Pl. Physiol., Lancaster *44*, 45 (1969).