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Foliar application of nitrate or ammonium as sole nitrogen supply in *Ricinus communis*

I. Carbon and nitrogen uptake and inflows

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SUMMARY

Following a precultivation with pedospheric nitrogen nutrition, nitrate or ammonium solutions were supplied to the shoots of *Ricinus* plants by spraying (during the experimental period) resulting in an increase of biotic/organic and abiotic/inorganic particles on the surface, which significantly increased wetting of the leaf surfaces. The distribution of particles on the surface of sprayed leaves, in particular crystals around and in stomata, indicated the possible entry of nutrients via thin water films through the stomatal pores in addition to diffusion through the cuticle. Ammonium was taken up more readily than nitrate by the foliage, but both at relatively low rates which caused N limitation. Interestingly, the inorganic N, both in the form of nitrate and even ammonium, was entirely assimilated in the shoots; phloem transport of inorganic N to the root was negligible. The flows of malate, and the acidification of the apoplastic washing solution of leaves in ammonium-sprayed plants pointed to the role of metabolism of malate and excretion of protons in maintaining pH during ammonium assimilation in the shoot. Ammonium-sprayed plants incorporated the N in the same amounts in shoots and roots, only 38% of the shoot-borne N being recycled in the xylem. In nitrate-sprayed plants the root was not only favoured in N partitioning, but even a net export of previously incorporated N from the shoots occurred which reflected the N limitation. The N limitation also affected carbon metabolism, in particular the flows of C, incorporation in the shoot and photosynthesis, which were decreased when compared with data from recent experiments with pedospheric well fed *Ricinus*. However, there was little difference in C flows between nitrate and ammonium-sprayed plants with respect to respiration, C partitioning and, most interestingly, in relative stimulation of root growth. The loss of C from dark respiration of the shoots was high on a f. wt basis as well as in relative terms, owing to exclusive N assimilation in the shoot. In general the plants invested untargeted increases in root growth as a result of N limitation irrespective of the imposed artificial treatment which made the shoot the site of mineral N uptake.

Key words: *Ricinus communis* L., foliar application, carbon, nitrogen, nitrate, ammonium, phloem transport, xylem transport.

INTRODUCTION

In higher plants, inorganic nitrogen is usually taken up by the roots as nitrate and/or ammonium. Shoot organs, however, can take up mineral nutrients as well (Clarkson, Kuiper & Lüttge, 1986; Raven, 1988; Marschner, 1995). In agriculture, a common method of fertilization is the application of nutrients by spraying a solution onto the leaves (foliar nutrition). Gaseous air pollutants like NO_2, NH_3 and SO_2 can also diffuse into shoot tissue and can be taken up into the cells. Uptake of the nutrients into the leaves could occur either by penetration through the stomata, or by diffusion through the cuticle. Once in the leaves, the nutrients must be dissolved in the aqueous phase of the cell wall before uptake into

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