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The uptake and flow of C, N and ions between roots and shoots in *Ricinus communis* L. III. Long-distance transport of abscisic acid depending on nitrogen nutrition and salt stress

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Abstract

Seedlings of *Ricinus communis* L. were cultivated in quartz sand and supplied with media which contained either different concentrations of nitrate or ammonium nitrogen and were treated with a low salt stress. The concentration of ABA was determined in tissues and in xylem and phloem saps. Between 41 and 51 day after sowing, abscisic acid (ABA) flows between roots and shoots were modelled. Long-distance transport of ABA was not stimulated under conditions of nitrate deficiency (0.2 mol m^{-3}). However, when ammonium was given as the only N source (1.0 mol m^{-3}), ABA transport in both xylem and phloem was increased significantly. Mild salt stress (40 mol m^{-3} NaCl) increased ABA transport in nitrate-fed plants, but not in ammonium-fed plants. The leaf conductance was lowered by salt treatment with both nitrogen sources, but it was always lower in ammonium-fed compared to nitrate-fed plants. A negative correlation of leaf conductance to ABA levels in leaves or flow in xylem was found only in comparison of ammonium-fed to nitrate-fed plants.

Key words: Abscisic acid, ammonium, *Ricinus communis*, phloem, xylem, transport, nitrate, nitrogen nutrition.

Introduction

It is known that the growth, morphology and physiology of higher plants are affected by cultural conditions. Nitrogen is arguably the most important nutrient (Clarkson and Hanson, 1980; Runge, 1983; Marschner, 1986), and nitrogen deficiency or an unfavourable nitrogen source may result in the transmission of a stress signal from root to shoot. Plants growing in nitrogen-deficient situations often show symptoms which resemble the xeromorphic responses of droughted plants (Stålfelt, 1956; Fahn and Cutler, 1992; Mothes, 1932; Simonis, 1948; Lundkvist, 1955, 1956). Some workers have also demonstrated an accumulation of ABA in the leaves of nitrogen-deficient plants, but in most cases the effect was small (tobacco: Mizrahi and Richmond, 1972; sunflower: Goldbach *et al.*, 1975; potato: Krauss, 1978; Marschner and Krauss, 1981; Krauss and Marschner, 1982; tomato: Chapin, 1990; Daie *et al.*, 1979; grapevine: Scienza and Düring, 1980; cotton: Radin and Ackerson, 1981; Radin *et al.*, 1982; barley and tomato: Chapin *et al.*, 1988). This may be due to analysis of total tissue extracts. Davies and Zhang (1991) and Zhang and Davies (1990) have demonstrated that drought-dependent ABA increases become much clearer when distinct compartmental fractions such as xylem or apoplastic saps were analysed. We have investigated the influence of N-nutrition on ABA concentrations in the transport fluids and organs of *Ricinus communis* and have used these data to describe quantitatively ABA flows in relation to N-nutrition. Similar work was done before by Wolf *et al.* (1990) with salt-stressed lupins. In the present paper, ABA flows were modelled for plants receiving different nitrate concentrations (0.2, 1.0 and 4.0 mol m^{-3}), ammonium (1.0 mol m^{-3}) and salt stress (40 mol m^{-3} NaCl with 1.0 mol m^{-3}

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Abbreviations: ABA: abscisic acid; dwt: dry weight; fwt: fresh weight.