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Journal of Experimental Botany, Vol. 47, No. 304, pp. 1737–1754, November 1996

Journal of Experimental Botany

Effects of P deficiency on the uptake, flows and utilization of C, N and H_2O within intact plants of *Ricinus communis* L.

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Received 8 December 1995; Accepted 16 April 1996

Abstract

The influence of P deficiency on the uptake, flow and utilization of C, N and H_2O by intact NO_3-fed castor bean plants (*Ricinus communis* L.) was studied over a 9 d period in the middle of their vegetative growth. The modelling techniques incorporated data on net increments or losses of C, N and H_2O in plant parts, photosynthetic gains in and respiratory losses of C, molar C:N ratios of solutes in phloem and xylem sap and transpirational losses of H_2O. Plant growth was inhibited within 3 d of withholding P supply and dry matter production was less than one-third of the controls. Leaf growth was particularly depressed, while root growth was much less affected than that of the shoot. Shoot:root ratio of low-P plants was 1.5 compared with 2.6 under P supply. Over the 9 d study period total plant C and N increased by 560 and 47 mmol, respectively, in the controls, but by only 113 and 6.9 mmol in the low-P treatment. The particularly low increment of N in P-deficient plants was due principally to decreased NO_3^- uptake. Flows of C and N during the study period were markedly different between control and P-deficient plants. The partitioning profile for C in P-deficient plants showed a dramatic inhibition of net photosynthesis and attendant photoassimilate flow. Proportional downward to upward allocation of carbon increased with increase in sink size of the root relative to shoot. This was reflected in greater relative allocation of C to root dry matter and root respiration than in P-sufficient plants, and suppressed cycling of C from root to shoot via xylem. Nitrogen intake and xylem transport to the shoot of P-deficient plants were only 15% of the control and, as in the case of C, downward allocation of N predominated over upward phloem translocation. Apart from these severe changes, however, the basic patterns of N flows including xylem-to-phloem and xylem-to-xylem transfer of N were not changed, a feature highlighting the vital nature of these transfer processes even under deficiency conditions. The alterations in flows and partitioning of C, N and H_2O in response to low-P conditions are discussed in relation to the corresponding effects of moderate salt stress in *Ricinus* and the conclusion is reached that changes in nutrient flows under P deficiency were more highly co-ordinated than when plants experience salt stress. Flow profiles under P deficiency which favour root growth and activity are viewed as a means for increasing the potential capability of the plant to acquire P from the nutrient medium.

Key words: *Ricinus communis* L., P deficiency, carbon, nitrogen, water, partitioning, xylem transport, phloem transport.

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Abbreviations: DAS: days after sowing, DM: dry matter, C_{min}: minimal concentration down to which the plants can reduce external ion concentration in the aqueous phase of the rooting medium.