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MOISTURE RELEASE CURVES OF SOIL GROWN ROOTS DETERMINED IN SITU

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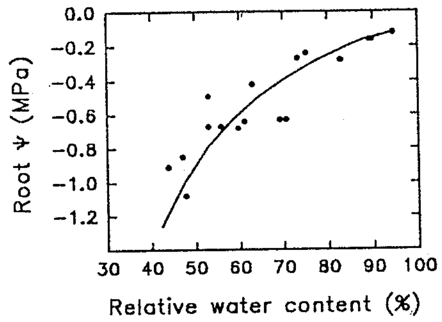
The moisture release curve (so-called pressure-volume curve) represents the relationship between the water potential, ψ, and the water content of the tissue, analogous to the moisture release curve of the soil. The moisture release curve of a leaf or branch is conveniently determined with a pressure chamber (Hsiao 1990). Analysis of the curve can yield values for the osmotic (solute) potential, ψ_s, and the pressure (turgor) potential, ψ_p, at any given ψ or water content of the sample. The same technique has recently been applied to roots of woody species (Parker et al 1988) and by us (Evéquoz et al 1992) to maize roots. Conventional pressure-volume curve techniques require separation of roots from adhering soil particles for soil grown roots. This can only be achieved by immersing roots in water and blotting then dry - a process which might lead in artefactual results. To overcome these difficulties we have developed a new technique which allows in-situ determination of moisture release curves of roots grown in soil.

Methods: One-day pre-germinated maize seeds (*Zea mays* L var Issa) were sown in pots (6 cm outer diameter, 5.5 cm inner diameter, 20 cm in height). The pots were longitudinally cut in two halves which were tightly taped together. Two inner rings (height 1 cm, diameter 5.45 cm) with a wire net of 1.5 mm mesh width at the base and separated by 2 cm distance were inserted halfway down in the pots. The pots were filled with a silt loam (fine, mixed mesic Aquic Ustifluvent) leaving the space empty between the rings. For the first 12 days the pots were watered regularly to ψ_m = -0.03 MPa. Thereafter half of the pots were allowed to dry, whereas the other half were well watered. Roots could freely grow through the empty space and were after removing the tape accessible for measurements. Clean root segments with about 1.8 cm length protruding through the empty space were quickly cut with a razor blade and used for the gravimetric determination of fresh and dry weight. Sap extracted from root segments of the same pot was used for the determination of ψ_s by vapour pressure osmometry. Gravimetrically determined soil water contents of mixed soil samples, taken from the vicinity of the empty space, were converted to soil matric potentials based on a previously determined soil water retention curve. Root segments in the empty space were assumed to have a comparable ψ to adjoining soil grown roots. Shoot and root were cut in the mesocotyl with a razor blade and shoot ψ was measured with a pressure chamber. Previous investigations showed that this value reflected volume-averaged ψ of the whole root system, (Schmidhalter et al 1992). Detailed ψ measurements in different parts of the whole root system indicated only small ψ gradients. In this previous work we also found that root ψ measured with a pressure chamber was more reliable than psychrometrically determined values. ψ_p was calculated as the difference between ψ and ψ_s. Dilution effects caused by the apoplast solution were considered to be negligible.

Results: The drop in ψ resulting from a decreased relative water content as shown in the figure was much more gradual in roots than has previously been reported for leaves of maize (Evéquoz et al 1992).



Capacitance, elasticity and osmotic adjustment were significantly higher in roots than in shoots of maize plants. Previously obtained results demonstrating fundamental differences in the elastic and osmotic properties of root and shoot tissues can be confirmed (Evéquoz et al 1992). However, the results of this study show that pressure-volume curves of roots have to be analyzed differently as compared with shoots. Conventionally determined pressure volume curves of roots agreed with this method if P-V-values at high relative water contents were discarded. For the first time, we could reliably and with high accuracy determine root tissue water contents of soil grown roots on a fresh weight basis and its relation to the soil matric potential.

Conclusions: A new technique has been developed to determine moisture release curves of soil grown roots. Tissue water content of soil grown roots can reliably be meaured and related to soil matric potentials. Fundamental differences in root and shoot proerties are shown.

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