

considered as being the major obstacle. The thickness of the water film might be an important parameter, but neither techniques for direct measurements nor a theory which relates it to the water status of the soil are available. A complete evaluation of the role of water films in field situations is thus impossible. As shown below, theoretically it does not give a full explanation of the 1%–10% disparity mentioned.

Other complications of the diffusion pathway have been mentioned in the literature. Oxygen consumption by rhizosphere microorganisms or by an ectomycorrhizal sheath may have an effect⁵. We have tried to evaluate these effects using the models of the preceding paper²¹.

Most measurements of root respiration reported in the literature include oxygen consumption by the rhizosphere. The relative contribution of the rhizosphere microorganisms is estimated to be up to one third of total respiration of root plus rhizosphere¹⁶. As a first approximation this oxygen sink may be assumed to be distributed evenly over the water film. Rhizosphere respiration obviously lowers the oxygen supply to the root. But as rhizosphere respiration has usually been included in measurements of root respiration, the latter has been overestimated to the same extent as the former is underestimated. A comparison should be made between situations with the same total respiration rate and varying distribution of the respiration activity over the root and water film.

The concept of a uniform water film obviously can only serve as a first approximation. Some parts of the root surface area are in direct contact with soil particles or small water-filled pores while others are in contact with larger air-filled pores, gaps and cracks (Fig. 1 of the preceding article²¹). Only for the last mentioned parts of the root is the water film of any importance. Entry of oxygen to the other part is virtually completely blocked (only a long route through water-filled pores is available). In recent theories of water uptake the possibility of a soil-root resistance plays a major role^{10,18,20}. The fact that only a part of the root circumference is in contact with the water-continuum of the soil probably restricts the possibilities for water uptake considerably. Oxygen uptake is probably restricted to the remaining part of the circumference. The consequences of this restriction are the main topic of this paper. The soil-root contact should be a compromise between the conflicting interests of a sufficient contact with the soil air and with soil water.

The soil-root interface is a recent focus of research⁹; progress so far has been limited by a lack of adequate techniques for direct observations. In some soils the immediate vicinity of the root can be