An appraisal of the electrical resistance method for assessing root surface area*

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Introduction

One root resistance method, termed the earth impedance method, is run at a single low frequency, and the absorbing root surface area is assessed accordingly. However, some recent studies suggest that the electrical current would not pass through the roots but at the root collar. The aim was to measure electrical resistance of roots in relation to their morphology and to assess the effect of the stem on electrical current pathways.

Materials and methods

Hydroponically raised willow cuttings (*Salix schwerinii*) were set in a constant electrical field (effective voltage of 0.1 V, sine-AC, 128Hz) in a hydroponic solution in three experimental set-ups (Fig.1). The electrical resistance of three components in the measurement system was measured. Roots were scanned (Epson Expression 1640XL) to assess the root surface area using image analysis (WinRhizo).

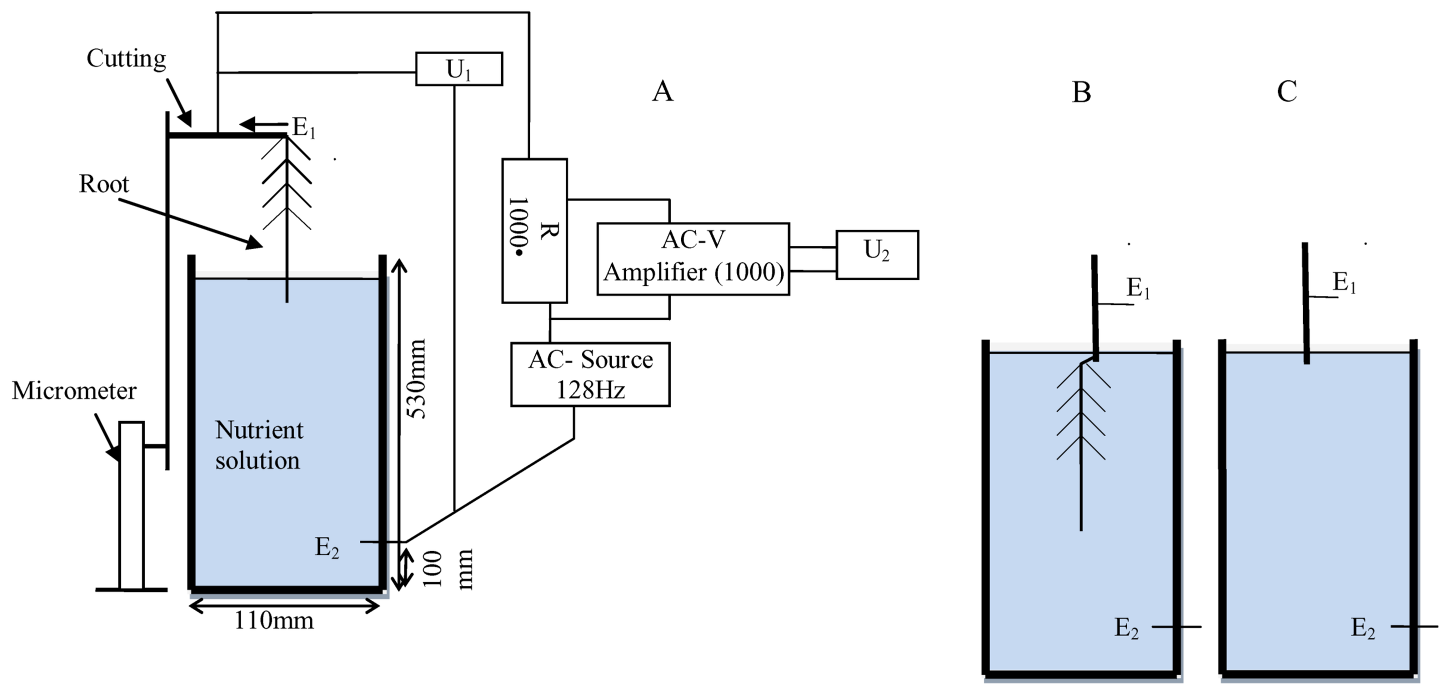

Fig.1 Diagram of the experimental set-ups for the measurement of electrical resistance of willow roots. (A) Only root in contact with the solution. (B) Whole root with a piece of stem in the solution. (C) A piece of stem in the solution.V1 and V2 are voltage meters. E1 and E2 refer to the silver electrodes. Note: The measurement circuitry in (B) and (C) is the same as in (A).

Results

The resistance and root surface area was significantly correlated when whole root systems of different plants were immersed in the solution (Fig. 2). Contact of the stem with the solution had a significant effect on the resistance. No difference was observed when the stem was in contact with the solution with or without the root (Fig. 3). A significant relation was found between cross-sectional area of the stem and the resistance of the stem as with or without the root immersed in the solution (Fig. 4).

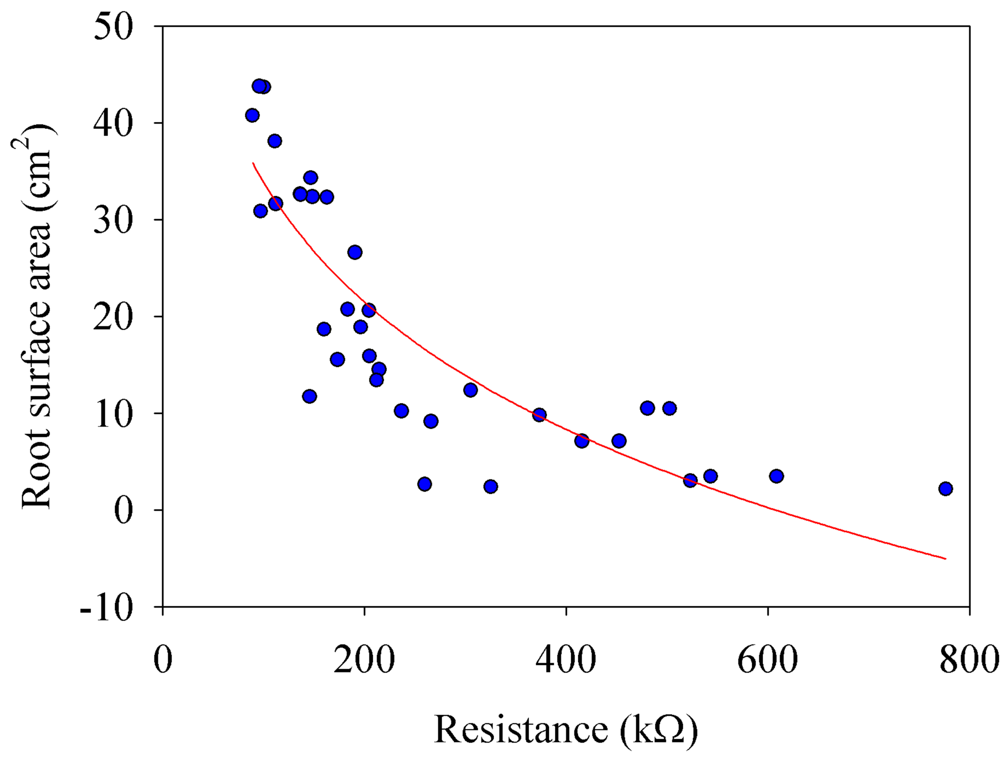

Fig. 2 Relation between the electrical resistance and root surface area for the intact willow roots as immersed in nutrient solution (see Fig. 1A).

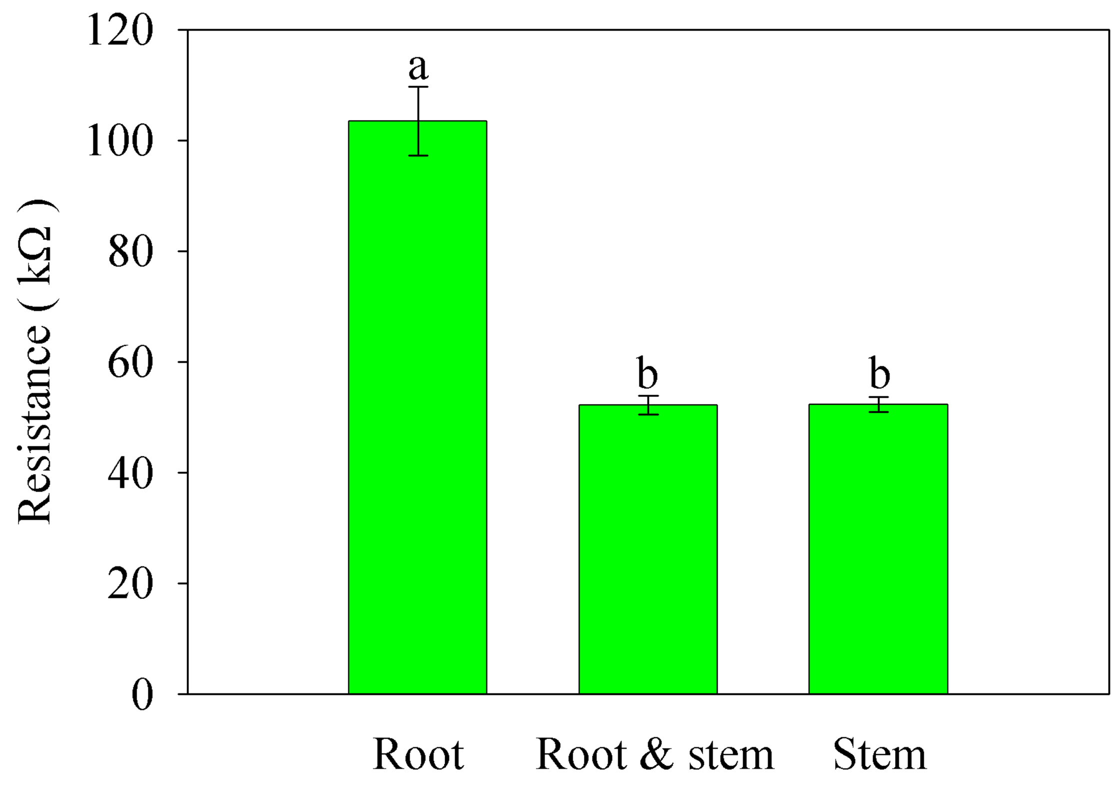

Fig. 3 The electrical resistance of intact root (Root), root and a piece of stem (Root & stem), and the stem only with the root dissected (Stem) as immersed in nutrient solution (see Fig. 1A, B and C, respectively).

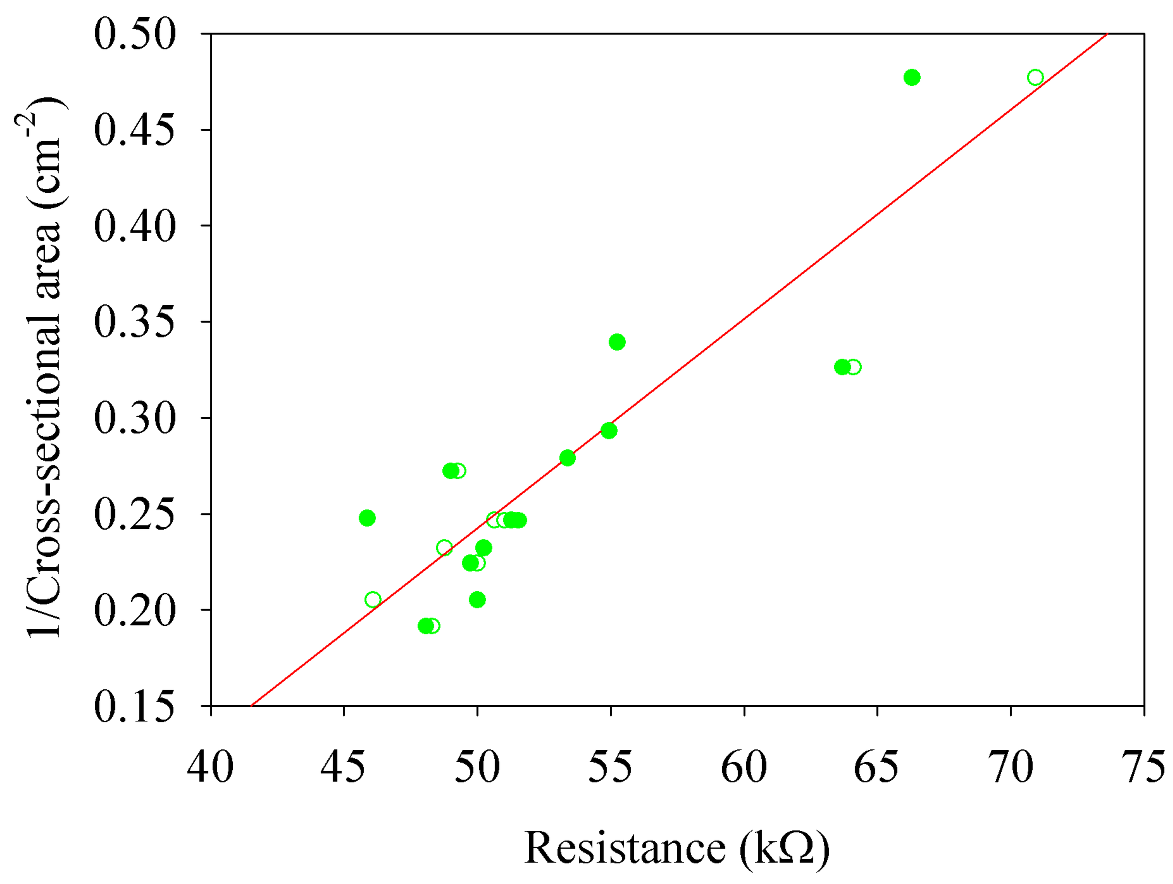

Fig. 4 Relation between the electrical resistances of willow cuttings (with and without root) and the cross-sectional area of the stems as immersed in the nutrient solution (see Fig. 1B and C, respectively). Open and closed symbols refer to the stems with and without root, respectively.

Conclusion

The resistance decreased in relation to the contact area of stem with the solution. However, the resistance depended strongly on the contact area of the stem with the solution, thus causing bias in the evolution of root surface area.

References

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