

# Digital Microscopy: A Useful Technique for Measuring Root Elongation in Solution

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Many techniques have been used to study the adverse effects of soluble Al on root growth.

## MARK ROOTS WITH INK LINES

This technique is used commonly with excised roots. Winch and Pritchard (1999) (J. Exp. Bot. 50, 1481- 1497) used intact roots to show that low pH loosens cell walls and accelerates root elongation.

## TRANSDUCER SYSTEM

Gunsé et al. (1992) (Plant Physiol. Biochem. 30, 499 - 504) used a computerised linear displacement transducer system to study Al effects. Roots and coleoptiles were attached to the transducer with silk thread.

## AGAR BLOCKS

Ryan et al. (1993) (J. Exp. Bot. 44, 437 - 446) placed agar blocks impregnated with Al next to maize roots grown horizontally, and concluded that exposure of the meristem is important in the toxic effect of Al.

## ROOT GROWTH THROUGH SEGMENTS

An innovative technique by Sivaguru and Horst (1998) (Plant Physiol. 116, 155 - 163) involved growing roots through individual 1-mm segments containing Al in agarose.

## COMPUTERISED VIDEO SYSTEM

To limit interference with the root, Parker (1995) (Plant Soil 171, 151 - 157) developed a video system to study the effects of Al by measuring wheat root length every 1-2 h for 48 h.

## DIGITAL MICROSCOPY

This is a development of the method of Parker (1995) that allows shorter time intervals between measurements and also permits investigation of parts of the root.

## STEPS IN DIGITAL MICROSCOPY

1. Germinate seeds in 1 mM Ca solution
2. After ca. 3 d, mark a root with activated carbon particles
3. Transfer seedling to a polycarbonate holder, and place root in control solution (1 mM Ca; pH 6)
4. Grow seedling in control solution for ca. 100 min, measuring root length and capturing a digital image every 5 min
5. Impose a treatment by adding an aliquot of  $AlCl_3$  stock solution
6. Continue measurement and digital image capture every 5 min for 4-7 h

The data depicted on the right are from Blamey et al. (2004) (Soil Sci. Plant Nutr. 50, 67-76)

## DATA MANAGEMENT

1. Plot root length against time

2. See computerised demonstration of soluble Al effects on root elongation available at: <http://www.uq.edu.au/lafs/Pax%20Blamey/demonstration.htm>

3. Use UTHSCSA Image Tool for Windows © developed by the University of Texas Health Science Centre at San Antonio, Texas: <http://ddsdx.uthscsa.edu/dig/itdesc.html>

This software allows the user to determine the location of individual activated carbon particles on each image. Plotted against time, this shows when and where Al has its initial detrimental effects

