



## Evaluating the Madeiran wheat germplasm for aluminum resistance using aluminium-induced callose formation in root apices as a marker

Teresa M. M. dos Santos<sup>1</sup>, Jan J. Slaski<sup>2,5</sup>, Miguel Â. A. Pinheiro de Carvalho<sup>1</sup>, Gregory J. Taylor<sup>3</sup>, Maria R. Clemente Vieira<sup>4</sup>.

<sup>1</sup>Centre of Macaronesian Studies, University of Madeira, 9000-390 Funchal, Portugal

<sup>2</sup>Environmental Technologies, Alberta Research Council, Vegreville, Alberta, T9C 1T4, Canada

<sup>3</sup>Dept. of Biological Sciences, University of Alberta, T6G 2E9, Canada

<sup>4</sup>Institute of Botany, University of Coimbra, 3000 Coimbra, Portugal

<sup>5</sup>corresponding author: e-mail: slaski@arc.ab.ca

**Key words:** aluminum, callose, Madeira, resistance, root elongation, wheat

### Abstract

Aluminum (Al) resistance of 57 Madeiran wheat cultivars was evaluated using callose content in root tips and root elongation as markers. Al induced callose formation was a very sensitive indicator of Al damage detecting wide range of genotypic differences existing in the Madeiran wheat germplasm. A weak, yet positive correlation ( $R^2=0.285$ ,  $P<0.05$ ) between callose content and root elongation was found.

### Introduction

Toxicity of aluminum (Al) is considered to be a major growth and yield limiting factor on mineral soils with pHs below 5.0 (Anioł 1990, Foy 1992). Soil acidity is a severe agricultural problem affecting about 40 % of the world's arable land (Haug 1984), including north-central part of continental Portugal. Under acidic conditions, monomeric aluminum species are released to soil solution from soil minerals and from polycationic, non-toxic aluminum complexes that exist at neutral pH. Once in

soil solution, soluble aluminum ions can be taken up by roots and consequently adversely affect plant growth. The first observable symptom of aluminum toxicity is reduction of root growth (Foy 1992). The ability of roots to continue elongation in the presence of Al ions in nutrient solution is often used to evaluate aluminum resistance of crops (Foy 1992). Using root elongation tests facilitated by the eriochrome cyanine staining method, we have recently found that several old wheat cultivars from the Atlantic Island of Madeira exhibited enhanced resistance to Al compared to a cultivar commonly used as a standard for Al resistance (Pinheiro de Carvalho *et al.* 2003). The history of wheat cultivation on the Island of Madeira began in the fifteenth century, when the first varieties were introduced from the Portuguese mainland followed by major introductions of wheat from the Canary Islands, Azores, North Africa and Southern and Northern Europe (Pinheiro de Carvalho *et al.* 2003). Cultivars adapted to acid soils predominant on the island were retained by farmers for cultivation. For decades, local farmers who operated on small plots, often located in remote and isolated mountain val-