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Fracture mechanics of tree root breakage as affected by prevailing wind direction

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Tree roots are anchors that prevent blowdown and mechanically reinforce soils. Roots on the windward side of trees have different strengths if compared with those on the leeward side, with morphological differences in shape, diameter, number and cross-sectional area of roots.
This study characterised root behaviour using tension, compression and bending tests, including the use of notched specimens to quantify fracture mechanics. On the windward side of trees, roots were hypothesised to be tougher, stronger and have greater Youngs Modulus than roots on the leeward side due to thigmomorphogenesis. This means that erratic changes in wind direction would be expected to exacerbate windfall damage.
Root samples from windblown trees with different directions of fall were mechanically loaded in either tensile, compression or bending to assess different failure mechanisms that affect root systems during windthrow. Fine roots ($\leq$ 3.2 mm) from the windward side were significantly (35.62 %) tougher than similar diameter roots perpendicular to the wind. However, the compression modulus of windward roots was significantly less than roots from other parts of the root plate. There were no differences in bending mechanical behaviour of roots in relation to the prevailing wind direction.
To our knowledge, this is the first fracture mechanics study of tree root breakage. As with other biomechanics research, it identified thigmomorphogenesis of windward roots through mechanical stimulation. Further analysis of root tissue structure and chemistry could explain the underlying biological control. Much more thorough sampling of the root system would be required to predict effects on windthrow, but the results suggest that a deviation from the prevailing wind direction could exacerbate windthrow susceptibility.