

# Can the Impairment of Root Growth by Soil Acidity be Overcome by Biochar Amendment?

Dr Qinhua Shen<sup>1</sup>, Dr Marta Camps-Arbestain<sup>1</sup>, Prof. Mike J. Hedley<sup>1</sup>, Dr Miko U.F. Kirschbaum<sup>2</sup>, Dr Peter Bishop<sup>1</sup>

<sup>1</sup>New Zealand Biochar Research Centre, Massey University, <sup>2</sup>Landcare Research, Private Bag 11052

Acid soils can inhibit the growth of plant roots both directly, by the effect of soil acidity itself, and indirectly, through the solubilisation of toxic aluminium (Al). Here we investigated whether root growth inhibition could be ameliorated by amending soil with biochar and, if so, through what mechanisms. The biochars were made from either pine or willow woodchips pyrolysed at 550°C. The biochars were added to two acid soils (Typic Dystrochrept and Alic Hapludand) at application rates were based on the pH-buffering capacities of both biochars and soils. Their effect was evaluated through (i) a radicle elongation bioassay using alfalfa (*Medicago sativa* L.) and (ii) a thorough chemical characterisation of the amended soils. The NaOH and Ca(OH)<sub>2</sub> were used to help understand the mechanisms. Biochar addition increased soil pH and decreased labile monomeric Al in all treatments; but only willow biochar stimulated alfalfa seedling growth. Willow biochar was found to be a suitable liming amendment for the Inceptisol under study, as 1% of willow biochar enhanced radicle elongation. However, unrealistic application rates (ca 5%) of the same biochar were needed by the Alic Hapludand which had abundant organo-Al complexes. An unbalance in the molar ratios of Ca/Na and Ca/Σ(dominant cations) in soil solution when adding pine biochar was the plausible cause of the stunted radicle growth observed with this amendment. The addition of pine biochar to the Alic Hapludand also increased aqueous colloidal Al in solution, which is consistent with an enrichment of Na over Ca in solution. We conclude that when selecting a specific biochar to ameliorate acid soils, not only the liming equivalence needs to be considered but also the balance of Na to Ca (and Mg) for adequate plant uptake and soil structure.