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Searching for plant root traits to improve soil cohesion and resist soil erosion

Sarah De Baets (1), Kevin Smyth (2), Tom Denbigh (2), Laura Weldon (2), Ben Higgins (4), Antoni Matyjaszkiewicz (3), Jeroen Meersmans (1), Isaac Chenchiah (4), Tannie Liverpool (4), Tim Quine (5), and Claire Grierson (2)

(1) School of Water, Energy and Environment, Cranfield University, Cranfield (Bedfordshire), United Kingdom, (2) School of Biological Sciences, University of Bristol, Bristol, United Kingdom, (3) School of Engineering Mathematics, University of Bristol, Bristol, United Kingdom, (4) School of Mathematics, University of Bristol, Bristol, United Kingdom, (5) Geography, University of Exeter, Exeter, United Kingdom

Soil erosion poses a serious threat to future food and environmental security. Soil erosion protection measures are therefore of great importance for soil conservation and food security. Plant roots have proven to be very effective in stabilizing the soil and protecting the soil against erosion. However, no clear insights are yet obtained into the root traits that are responsible for root-soil cohesion. This is important in order to better select the best species for soil protection. Research using Arabidopsis mutants has made great progress towards explaining how root systems are generated by growth, branching, and responses to gravity, producing mutants that affect root traits. In this study, the performance of selected Arabidopsis mutants is analyzed in three root-soil cohesion assays. Measurements of detachment, uprooting force and soil detachment are here combined with the microscopic analysis of root properties, such as the presence, length and density of root hairs in this case. We found that Arabidopsis seedlings with root hairs (wild type, wer myb23, rsl4) were more difficult to detach from gel media than hairless (cpc try) or short haired (rsl4, rhd2) roots. Hairy roots (wild type, wer myb23) on mature, non-reproductive rosettes were more difficult to uproot from compost or clay soil than hairless roots (cpc try). At high root densities, erosion rates from soils with hairless roots (cpc try) were as much as 10 times those seen from soils occupied by roots with hairs (wer myb23, wild type). We find therefore root hairs play a significant role in root-soil cohesion and in minimizing erosion. This framework and associated suite of experimental assays demonstrates its ability to measure the effect of any root phenotype on the effectiveness of plant roots in binding substrates and reducing erosion.