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Carbon content and pore network of a silt loam soil under different agricultural management practices

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Organic carbon and soil structure are strongly interrelated. Organic carbon is a binding agent important for stabilizing aggregates. Stable aggregates can protect organic matter from microbial decomposition. Our hypothesis for this study is that long-term intensive agricultural management practices will deplete topsoil carbon stocks, which in turn affects structural characteristics including pore size distribution, connectivity and tortuosity of the surface soil. Such changes will also influence the soil's capacity to deliver its key functions including water infiltration, nutrient and water cycling and storage, as well as gas exchange.

We analysed the effect of long-term irrigation and intensive cultivation practices on the chemical and physical soil quality of an arable silt loam soil. Chemical and physical soil health parameters including carbon and nitrogen contents, total biomass, Olsen-P and bulk density were analysed on bulk topsoil (0-5 cm) samples collected from different treatments of a long-term tillage and irrigation research site in Canterbury, New Zealand. In addition, the 3D-macro-pore networks of undisturbed topsoil cores (5 cm diameter x 5 cm depth) collected from the same sites were derived with X-ray computed tomography (CT).

Long-term irrigation and tillage significantly ($P<0.05$) reduced the topsoil's chemical soil quality in all parameters analysed with the exception of soil pH. Based on these results, we expected less macro-pores and more small pores under the intensive management. The traditional physical soil health analysis confirmed this: bulk density was significantly ($P<0.05$) higher for the intensively tilled soil, which reduced the total porosity. The same trend was found for the irrigation treatment but the results were not significant. The X-ray CT analysis revealed a macro-porosity of about 7% for all topsoils. This was not affected by management. However, the pore size distribution was significantly ($P<0.05$) influenced by long-term irrigation, and warrants a more in depth analysis of other morphological parameters of the macro-pore network. Potential correlations between soil structural parameters and physico-chemical soil properties will be discussed.