

The impact of soil carbon management on the biophysical soil quality: The comparison of an organic and integrated apple orchard in Hawke's Bay

Within the Sustainable Land Use Research Initiative (SLURI) HortResearch Sustainable Land Use team studied the impact of soil carbon (C) management on various soil quality related properties on an organic and a neighboring integrated apple production system in the Hawke's Bay region.

Both orchards have the same general soil characteristics. The soils are Fluvisols and have a silt-loam texture. The organic orchard system had been under organic management (BioGro) since 1997. The apple trees in the orchard were 13 years old. The apple variety was 'Braeburn', and the rootstock variety was 'MM.106'. Green-waste compost was applied to the topsoil of the tree rows once a year at a rate of 5 to 10 t/ha, and lime was added at a rate of 300 kg/ha every 4 years. Pasture was grown in the tree rows. Lime-sulfur and copper were used as fungicides if needed.

The apple trees in the adjacent integrated orchard system were 12 years old. The apple variety was Pacific Rose™, and the rootstock variety was 'MM.106'. A 0.5-m wide strip under the trees was kept bare by regular herbicide applications. The apple trees were drip-irrigated during the vegetative period. The irrigation, nutrient, and pest management followed the guidelines of integrated fruit production. Before their use as orchards both sites were used for market gardening.

We compared the carbon status of the two orchards and its impact on the soil biology (microbial activity, earthworm fresh weights) and the physical soil structure in the top 10 cm of the tree rows. These were our key findings:

- The organic orchard soil contained with 3.8 kg C/m² significantly more carbon than the integrated system with 2.6 kg C/m²
- The monthly average of microbial activities in 2006 was with 143±40 g microbial biomass C/m² significantly higher in the organic than in the integrated system with 73±16 g microbial biomass C/m².
- The monthly average of earthworm fresh weights in 2006 (top 20 cm) was with 154±47 g/m² significantly higher in the organic than with 85±53 g/m² in the integrated system
- The soils macropore structures were measured with 3D X-ray computed tomography in July 2007, and were significantly different in both systems (Figure 1). Macropores are pores with a diameter larger than 0.3 mm. The organic orchard had with 8.7±2 Vol.% significantly higher macroporosities than the integrated system with 2.8±2 Vol.%. The macropore diameter was on average with 0.8 mm the same in both systems. The connectivity and continuity of macropores was also significantly higher in the organic compared to the integrated system (Figure 2). Therefore, under wet conditions, the soil aeration is more efficient in the organic compared to the integrated orchard.

From the results of the study we conclude that the soil carbon management that is typical for organic orchard systems increased both the carbon sequestration and the biophysical soil quality. For more details see our publications (Vogeler et al., 2006; Deurer et al., 2008) or contact us by email: mdeurer@hortresearch.co.nz.

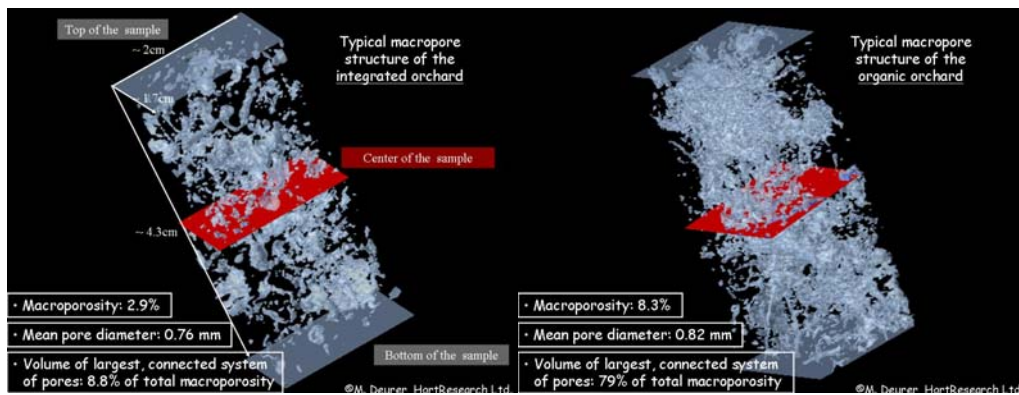


Figure 1: Typical soil macropore structures in three dimensions for the two orchard systems. The macropore networks within the soil are shown as grey areas. **Left:** Integrated orchard. **Right:** Organic orchard.

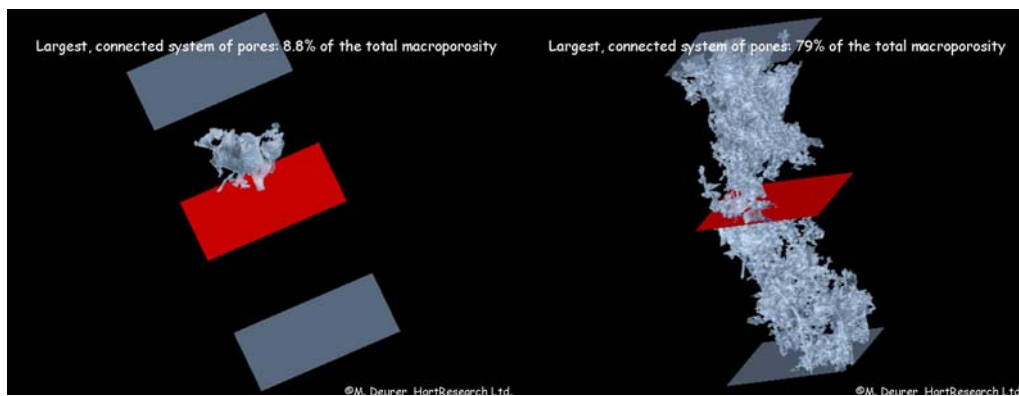


Figure 2: The connectivity and continuity of the macropore networks shown in Figure 1. The macropore networks within the soil are shown as grey areas **Left:** The largest connected system of macropores shown in Figure 1, Left (integrated orchard) **Right:** The largest connected system of macropores shown in Figure 1, Right (organic orchard)

Reference:

- Deurer M, Sivakumaran S, Ralle S, Vogeler I, McIvor I, Clothier BE, Green S, Bachmann J 2008. A new method to quantify the impact of soil carbon management on biophysical soil properties: The example of two apple orchard systems in New Zealand. *Journal of Environmental Quality*, accepted.
- Vogeler I, Cichota R, Sivakumaran S, Deurer M, McIvor I 2006. Soil assessment of apple orchards under conventional and organic management. *Aust. J. Soil Res.* 44: 745-752.