

DOK-Monte Verità – 6 – 11 October, 2019, Congressi Stefano Franscini, Monte Verità, Ascona, Switzerland

Long-term organic matter application reduces cadmium but not zinc concentrations in wheat

R. Grüter^{a,b}, B. Costerousse^c, J. Mayer^d, P. Mäder^e, C. Thonar^e,
Emmanuel Frossard^c, R. Schulin^b and S. Tandy^b

^a *Geography of Food, Institute of Natural Resource Sciences,
Zurich University of Applied Sciences (ZHAW), Wädenswil, Switzerland*

^b *Soil Protection, Institute of Terrestrial Ecosystems, Department of Environmental Systems Science,
ETH Zurich, Switzerland*

^c *Plant Nutrition, Institute of Agricultural Sciences, Department of Environmental Systems Science,
ETH Zurich, Switzerland*

^d *Nutrient Flows, Institute for Sustainability Sciences, Agroscope, Zurich, Switzerland*

^e *Department of Soil Sciences, Research Institute of Organic Agriculture (FiBL), Frick, Switzerland*

Wheat is a staple food crop and a major source of both the essential micronutrient zinc (Zn) and the toxic heavy metal cadmium (Cd) for humans. Since Zn and Cd are chemically similar, increasing Zn concentrations in wheat grains (biofortification), while preventing Cd accumulation, is an agronomic challenge. We used two Swiss agricultural long-term field trials, the “Dynamic-Organic-Conventional System Comparison Trial” (DOK) and the “Zurich Organic Fertilization Experiment” (ZOFE), to investigate the impact of long-term organic, mineral and combined fertilizer inputs on total and phytoavailable concentrations of soil Zn and Cd and their accumulation in winter wheat (L.). “Diffusive gradients in thin films” (DGT) and diethylene-triaminepentaacetic acid (DTPA) extraction were used as proxies for plant available soil metals. Compared to unfertilized controls, long-term organic fertilization with composted manure or green waste compost led to higher soil organic carbon, cation exchange capacity and pH, while DGT-available Zn and Cd concentrations were reduced. The DGT method was a strong predictor of shoot and grain Cd, but not Zn concentrations. Shoot and grain Zn concentrations correlated with DTPA-extractable and total soil Zn concentrations in the ZOFE, but not the DOK trial. Long-term compost fertilization led to lower accumulation of Cd in wheat grains, but did not affect grain Zn. Therefore, Zn/Cd ratios in the grains increased. High Zn and Cd inputs with organic fertilizers and high Cd inputs with phosphate fertilizers led to positive Zn and Cd mass balances when taking into account atmospheric deposition and fertilizer inputs. On the other hand, mineral fertilization led to the depletion of soil Zn due to higher yields and thus higher Zn exports than under organic management. The study supports the use of organic fertilizers for reducing Cd concentrations of wheat grains in the long-term, given that the quality of the fertilizers is guaranteed.