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

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1 Background

- Zinc (Zn) deficiency in human populations is a global nutritional problem
- Zn deficiency is caused by imbalanced diets, especially if cereals are the main source of calories and Zn
- Wheat is a major contributor of both Zn and cadmium (Cd), which are chemically similar, to humans
- Increasing Zn concentrations of wheat grains (biofortification) is an important agricultural challenge
- Accumulation of the toxic heavy metal (Cd) must be prevented

2.1 DOK long-term field trial

- Farming system comparison
- Est. 1978, Basel, Switzerland
- Treatments (replicated in 4 blocks)
  - **NOFERT**: unfertilized control
  - **CONMIN**: mineral fertilization only
  - **CONFYM**: mineral fertilization + farmyard manure
  - **BIODYN**: composted farmyard manure

2.2 ZOFE long-term field trial

- Fertilization comparison
- Est. 1949, Zurich, Switzerland
- Treatments (replicated in 5 blocks)
  - **NON**: unfertilized control
  - **NPK**: mineral fertilizers
  - **FYM**: farmyard manure
  - **COM**: compost

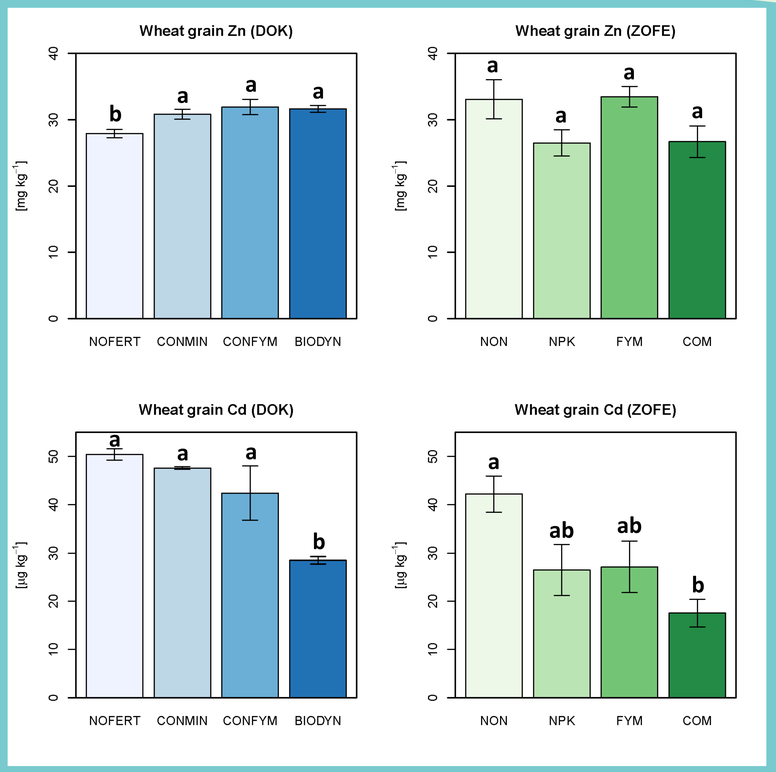
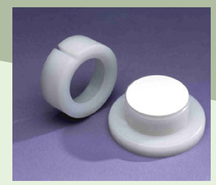


Figure 1: Wheat grain Zn and Cd concentrations in DOK (left) and ZOFE (right) field trials.

2.3 Zn & Cd phytoavailability

- Assessment methods:
  - **DGT** method: diffusive gradients in thin films →mimics a plant root
  - **DTPA** extraction: diethylene-triamine-pentaacetic acid →classical chemical extraction



DGT

DTPA

3.1 Results

- Organic fertilizer application increased both soil pH and soil organic carbon, which were strongly correlated (DOK: R^2 = 0.43***, ZOFE: R^2 = 0.92***)
- DGT-available soil Zn and Cd showed a strong negative correlation with soil organic carbon (Figure 2), pH and cation exchange capacity
- Wheat shoots and grains accumulated less Cd when more organic matter was applied (Figures 1 and 2)
- Wheat shoot and grain Zn concentrations (Figure 1) did not correlate with DGT but were related to total and DTPA-extractable soil Zn

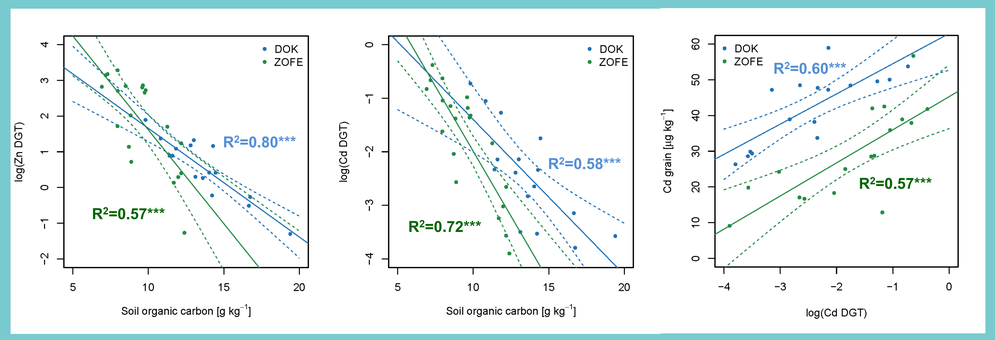


Figure 2: Negative correlations between soil organic carbon and DGT-available Zn (left) and Cd (middle) and positive correlations between DGT-available Cd and wheat grain Cd (right).

4 Conclusions

- Long-term organic matter inputs decreased available soil Zn and Cd through increasing soil pH and metal binding capacity
- There is a **potential of long-term compost application** to reduce Cd phytoavailability
- As **desired for human nutrition**, long-term organic fertilizer addition increased Zn/Cd ratios of wheat grains

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