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Farmer′s little helper – Earthworms' and collembolans' potential role in pathogen repression and reduction of environmental contaminants

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Current and future agriculture is facing huge challenges such as continuous degradation of soils and the accompanying loss of soil biodiversity. Another threat to agricultural production poses the change of the global climate since more favourable conditions for certain pathogens are predicted. Thus, changed patterns and distributions of toxigenic pathogens may lead to an increased plant disease incidence and higher mycotoxin levels in crop products and crop residues. By leaching from host tissue of infected plants and plant material, mycotoxins can be detected as potential environmental contaminants in soil and water. In the soil food web, fungivorous species have been proven to be antagonistic to a Fusarium infection and a mycotoxin contamination and act, therefore, as biological and chemical regulators contributing to the natural self-regulation in the soil system. Within the EU-project SoilMan, a microcosm-study with earthworms (Aporrectodea caliginosa) and collembolans (Proisotoma minuta) was conducted in the climate chamber to assess their biocontrol-impact on the fungal plant pathogen Fusarium graminearum and the content of its mycotoxins deoxynivalenol (DON) and zearalenone (ZEN) in finely chopped maize stubbles, soil, and leaching water. In the context of pathogen repression and detoxification of mycotoxins by soil organisms in agroecosystems it is hypothesised that (1) processes related to services or disservices are induced and directed by abundance and activity of functional groups of soil biota; (2) dynamics and interaction in the soil biota community control ecosystem function and services is influenced by temperature. Therefore, soil fauna in different numbers and combinations was exposed to artificially infected maize stubbles highly contaminated with DON (10,462 μg kg-1) and ZEN (2,780 μg kg-1) at 17°C and 25°C. After an experimental time span of 6 weeks, maize, soil, and leaching water samples were analysed for mycotoxin occurrence via liquid chromatography coupled to high resolution mass spectrometry (LC-HRMS).
First results clearly indicate faunal effects of both introduced species on DON reduction in residual maize. Moreover, the detoxification effect of soil fauna was influenced significantly by the temperature regime. At 25°C, DON was reduced most in mixed faunal treatment compared to the non-faunal control. A faunal effect on ZEN reduction was not observed. Further results are expected shortly on fungal DNA content in residual maize and soil as well as mycotoxin concentrations in soil and soil water. Our results contribute to a deeper understanding of functional interactions and the provision of ecosystem services across trophic levels within the soil food web of agroecosystems.