Earthworm diversity and soil structure and water regulation under climate mitigation measures for agricultural soils

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EJP SOIL MINOTAUR

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Background

Climate change threatens agricultural production, and mitigation measures need to be tested for effectiveness. Subsequently, functional relationships between soil biodiversity and soil functions and the provisioning of ecosystem services need evaluation.

Objective

The EJP SOIL MINOTAUR project aims to assess the effectivity of mitigation measures such as the extension of crop rotation cycles to include grassland on soil biodiversity and soil structure maintenance and water regulation processes. Special attention is given to the quantification of relations between earthworms and soil microaggregate stability, porosity and water infiltration rate.

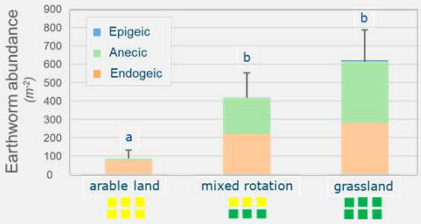
Methods

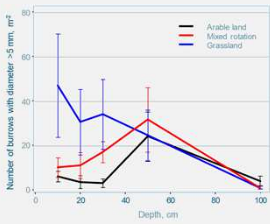
Data were obtained after six years of field study on replicated plots of different land management scenarios (permanent grassland, permanent arable cropping, mixed 3 years crop + 3 years grassland) at INRAE Poitou Charentes experimental farm at Lusignan, France. Aggregate stability was measured using wet sieving method. Macropore distribution (i.e., density and diameters of earthworm burrows) was quantified at different soil depths. Earthworms were sampled using hand sorting and chemical extraction.
Infiltration rates were measured as the saturated hydraulic conductivity.

Results

Earthworms

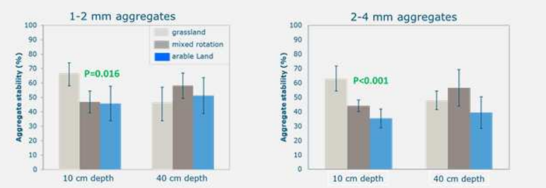
The local earthworm community consisted of 13 species: one epigeic, seven anecic and five endogeic. Populations were larger under mixed rotation and permanent grassland, where anecics thrived well and produced more burrows. Burrow density and depth distribution of large macropores (>2.5 mm) was also affected by crop rotation management (arable < mixed crop-grassland < grassland).



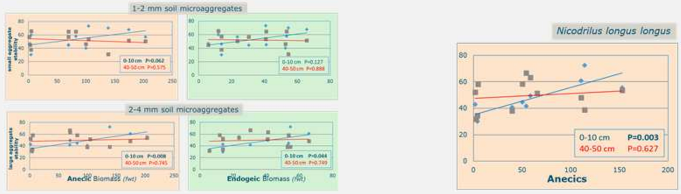


Soil aggregates

Soil microaggregate stability was higher in permanent grassland topsoil than in plough layers at 10 cm depth, not different at 40 cm depth.

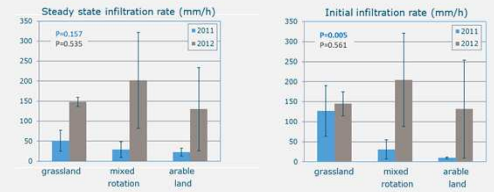


Aggregate stability in topsoil (0-10 cm) increased with anecic and endogeic earthworm biomass, not at 40-50 cm depth. Specific earthworm species correlations were found.

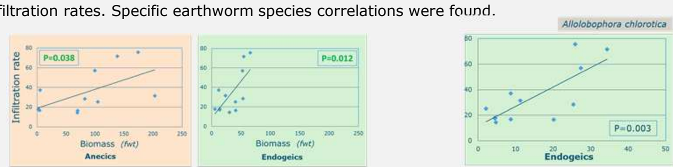


Water infiltration

Steady state water infiltration rate was not affected by management, but initial infiltration rates – an estimate for topsoil pore volume – decrease for permanent grassland to permanent arable land.



Steady state water infiltration rates were related to functional diversity in earthworms, through the mediation of specific soil macropores by various species; pore systems and burrows that were connected to the soil surface contributed most efficiently to water infiltration rates. Specific earthworm species correlations were found.



Conclusions

- The observations indicate that the extension of crop rotation cycles to include grassland for the purpose of climate mitigation can result in increasing earthworm functional biodiversity and hence improve soil structure and water infiltration.
- The results provide quantitative insights that can facilitate soil quality modelling (forecasting) and economic valuation.

Acknowledgements

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