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Biological subsoil management: new insights into processes of structure building and implications for crop growth

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Large sized continuous biopores (diameter > 2 mm) in arable subsoils can contribute to enhance soil aeration, increase water infiltration, reduce water runoff and serve as preferential pathways for root growth. Biopores can be generated by taproots, but these pores probably have limited physical stability unless they are colonized by anecic earthworms and coated with worm cast. Long-term field experiments have shown that populations of anecic earthworms and numbers of biopores are promoted by perennial fodder cropping, no-till cropping and reduced tillage systems, i.e. extended soil rest.
Potential effects of biopores on root growth of annual crops include accelerating access to deep soil layers, facilitating exploitation of water while simultaneously allowing nutrient acquisition from the pore wall and the bulk soil. Biopores can be considered as hot spots for nutrient acquisition of crops, especially when the pore wall is enriched in nutrients as a consequence of deposition of decaying plant material and feces of earthworms.
However, the extent of such effects largely depends on physical properties of the bulk soil. Preferential root growth through biopores has been observed in many types of subsoil. The role of biopores is expected to be relevant especially when rooting in the bulk soil is impeded by high penetration resistance. Nevertheless, in hard-setting clay soils clumping of roots has been reported, when roots were unable to re-enter the bulk soil from biopores' lumen.
Recent field experiments on a deep loamy Haplic Luvisol indicated increased biopore density in the subsoil promoting root growth of winter cereals and winter oilseed rape not necessarily resulting in significant effects on shoot parameters. Nevertheless, in a dry year increased biopore density had beneficial effects on N uptake, root and shoot growth and grain yield of spring crops.