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Beneficial soil fungi boosted by organic farming with reduced tillage

The biodiversity and abundance of arbuscular mycorrhizal fungi — important soil organisms that can help plants to capture nutrients — is greater in organically managed soils with reduced tilling compared to conventional methods, a new Swiss study suggests. This illustrates the impacts that land management practices such as ploughing can have on soil biodiversity and the ecosystem services it provides.

Soil organisms are important for nutrient cycling, and there has been some suggestion that their decline may increase the need for artificial fertilisers. Arbuscular mycorrhizal fungi (AMF) are found in the roots of most land plants, including agricultural crops, and can help supply nutrients to the plants. However, they can be vulnerable to some agricultural practices such as ploughing or tilling, which disturbs the top layers of soil.

For this study, researchers compared the AMF communities in the clay soils of seven sites, all in close proximity to each other in a Swiss Valley. Four of the sites were long-term, organic field experiments, each site divided into sub-plots to compare the combination of different management options of the land: two tillage systems — reduced and normal tillage, and two fertilisation regimes — applying farmyard compost and slurry or slurry only. One of the other three sites was organically managed grassland, while the other two were cultivated using conventional farming practices — normal or semi-reduced tillage, and the application of mineral fertilisers on both sites.

For all seven plots, the researchers took soil samples from four layers — top soils (0–10 cm and 10–20 cm deep) and undisturbed sub-soils (20–30 and 30–40 cm deep). The researchers also cultivated AMF communities in pots from soil taken from six sites. The pots were planted with seeds from four different plant species and kept in a greenhouse for 20 months.

The results show that although the researchers found that fertilisation regimes affected the AMF communities in the seven sites, tillage practices had a stronger impact. The number of AMF species collectively identified through field samples and the soil cultivation experiments was greatest in the grassland site, at 38. This dropped to 33 species in the two reduced-tillage organic sites, 28 in the one of the conventionally ploughed organic sites and to 28 in the conventionally managed site with normal tillage. Overall, 32 species were found in the conventionally farmed site with semi-reduced tillage.

Furthermore, the number of spores and diversity of AMF species was highest in the top soils of the grassland, next highest in the top soils of the two experimental plots where reduced tillage was used and lowest in the two experimental plots that had undergone normal tillage. Normal tillage disrupts the extensive spread of hyphae, fine strands of the fungi that form in the top soil layers, affecting spore production. Across all sites, the number of spores and different AMF species were lower in the bottom layer (30–40 cm) than in the top layer.

AMF diversity was also higher in reduced-tillage plots compared to normally tilled plots. Some AMF species are better adapted to the effects of ploughing than others and may dominate AMF communities in normally tilled soils, reducing their overall diversity.

Together, these results show that organically managed soils can produce diverse AMF communities that will benefit plant nutrition, productivity and health and enhance sustainable agricultural practices.

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