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Soil quality and crop yield decline under plastic tunnels

Recent research in Italy has suggested that soil quality deteriorates over time when intensively farmed under plastic tunnels. The tunnels are an obstacle to natural rainfall and artificial irrigation increases soil salinity and, as a consequence, agricultural yields can be significantly reduced.

Maintaining the productivity and biological health of soil should be amongst the goals of sustainable agriculture, especially as soil quality is known to be declining around Europe. To help address this, the European Commission has proposed a Soil Thematic Strategy[1], supporting research into soil function under the Seventh Framework Programme[2].

Carbon content is considered a key property when defining soil quality, but many other parameters are needed to characterise the functions of physical, chemical and biological features, such as water retention, nutrient cycling and disease suppression. Enzymes and microbial processes are particularly important for soil's ability to cope with environmental disturbance or stress. Many plant diseases are emerging in intensely managed farms and farmers respond with an increase of agricultural inputs, such as fertilisers and pesticides, to maintain productivity.

The researchers suggested that plastic tunnels profoundly affect soil quality as they block natural rainfall and artificial irrigation increases soil salinity. Furthermore, removed crop residues to reduce pathogen spread, coupled with high temperatures and intensive tillage, greatly enhance soil organic matter losses.

To test this assumption, the researchers measured the quality of various soils under high-intensity management regime (HIMR) at 20 farms which used plastic tunnels in five areas with different soil types, in Salerno, Southern Italy. This is a very productive area and crops grown under HIMR include lettuces, tomatoes, melons, peppers, cabbages and beans. These were compared to low-intensity management regime (LIMR) on the same soils, represented by orchards (largely peach, orange and kiwi) because directly comparable low-intensity arable farming is not supported in the area.

The farmers were surveyed to obtain soil history, including HIMR treatments, such as intensive tillage and application of fertilisers and soil fumigants. Soil samples taken from each site were tested for 31 separate physical, chemical and biological parameters.

Among the 31 tested parameters, 29 were affected by the management regime. Organic carbon in the upper soil layer (usually a very stable quantity) was 24 per cent lower in HIMR than in LIMR, indicating a deeply altered carbon cycle. High salinity arose from high levels of evaporation and heavy application of mineral fertilisers and soil fumigants. Microbial respiration, biomass and diversity, as well as the fungi to bacteria ratio, which influences enzymatic activity, were all reduced under HIMR.

The soils' capability to sustain lettuce growth was assessed by comparing HIMR and LIMR farms. Crop yield was 17 per cent higher in LIMR soils, despite higher content of mineral nutrients in HIMR soils. In addition, experiments revealed that lettuces grown in HIMR soils were less able to resist an introduced plant pathogen (*Rhizoctonia solani*). Reduction in lettuce growth in HIMR soils could not be explained by any single parameter, reinforcing the assumption that good soil quality results from a complex array of factors.

1. See: http://ec.europa.eu/environment/soil/index_en.htm
2. See: http://cordis.europa.eu/fp7/ideas/home_en.html

Source: Bonanomi, G., D'Ascoli, R., Antignani, V., et al. (2011) Assessing soil quality under intensive cultivation and tree orchards in Southern Italy. *Applied Soil Ecology*. 47: 184-194.

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