

Soil organic matter and biological soil quality indicators after 21 years of organic and conventional farming

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Abstract

Organic farming systems often comprise crops and livestock, recycle farmyard manure for fertilization, and preventive or biocontrol measures are used for plant protection. We determined indicators for soil quality changes in the DOK long-term comparison trial that was initiated in 1978. This replicated field trial comprises organic and integrated (conventional) farming systems that are typical for Swiss agriculture. Livestock based bio-organic (BIOORG), bio-dynamic (BIODYN) and integrated farming systems (CONFYM) were compared at reduced and normal fertilization intensity (0.7 and 1.4 livestock units, LU) in a 7 year crop rotation. A stockless integrated system is fertilized with mineral fertilizers exclusively (CONMIN) and one control treatment remained unfertilized (NOFERT). The CONFYM system is amended with stacked manure, supplemental mineral fertilizers, as well as chemical pesticides. Manure of the BIOORG system is slightly rotted and in BIODYN it is composted aerobically with some herbal additives. In the third crop rotation period at normal fertiliser intensity soil organic carbon (C_{org} , w/w) in the plough layer (0–20 cm) of the BIODYN system remained constant and decreased by 7% in CONFYM and 9% in BIOORG as compared to the starting values. With no manure application C_{org} -loss was severest in NOFERT (22%), followed by CONMIN together with the systems at reduced fertiliser intensity (14–16%). Soil pH tended to increase in the organic systems, whereas the integrated systems had the lowest pH values. At the end of the third crop rotation period in 1998 biological soil quality indicators were determined. Compared to soil microbial biomass in the BIODYN systems the CONFYM soils showed 25% lower values and the systems without manure application were lower by 34%. Relative to the BIODYN soils at the same fertilization intensity dehydrogenase activity was 39–42% lower in CONFYM soils and even 62% lower in soils of CONMIN. Soil basal respiration did not differ between farming systems at the same intensity, but when related to microbial biomass ($q\text{CO}_2$) it was 20% higher in CONFYM soils and 52% higher in CONMIN as compared to BIODYN, suggesting a higher maintenance requirement of microbial biomass in soils of the integrated systems. The manure based farming systems of the DOK trial are likely to favour an active and fertile soil. Both, C_{org} and biological soil quality indicators were clearly depending on the quantity and quality of the applied manure types, but soil microbial biomass and activities were much more affected than C_{org} .

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1. Introduction

The cycling of elements on the farm is a main principle of organic farming systems that are based on three practical pillars: (1) the maintenance and increase of soil fertility by

the use of farmyard manure; (2) the omission of synthetic fertilizers and synthetic pesticides; (3) the lower use of high energy consuming feedstuff. Since many soil and crop treatments are also beneficial to the environment without being directly productive, organic but also integrated farmers receive financial support for their environmental services in many countries. Economic performance (Stolze et al., 2000), efficiency calculations (Alföldi et al., 1999),

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