

Reduced tillage in organic farming: Impact on microbial activity and functional and structural diversity of soil microbial community

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1. Objective

Particularly ploughing is the central tillage technique for weed control in organic farming systems. However, there is much evidence that ploughing may result in a decrease in soil organic matter relative to reduced or no tillage. Conventional tillage also vastly influence the detritus food web in soil. Nonetheless, since plant nutrition in organic farming is maintained mainly through the soil organic substance and the detritus food web organically farmed soils should be rich in organic matter content and thereby highly biologically active. To bridge the gap between weed control on one hand and the enhancement of soil organic substance and detritus food web on the other the effects of reduced and conservation tillage techniques on soil ecological properties of an organically farmed soil has been proved.

The aim of the study therefore was to investigate the effects of no tillage, reduced and conservation tillage, namely two-layer plough and layer-cultivator in organic farming system on the activity and the functional and structural diversity of the soil microbial community relative to plough.

2. The study site

The experimental field was situated at the "Eichenhof" in central Rhine-Hessia near Mainz (Germany) at an altitude of 230 m. Mean annual temperature at this site is 10°C and annual precipitation varies between 500 to 600 mm. The experimental design consisted of 30 plots, each 12 x 100m in area. A five-crop rotation schedule starting in 1995 included green fallow, winter wheat with intercrop, peas, winter rye with intercrop and summer barley. The green fallow plots have been mulched for several times each vegetation period since one additional aim of the project is to simulate organic farming practice without livestock. Each crop was combined with three different tillage techniques with each of the fifteen crop/tillage treatments being replicated twice in the experimental field. The tillage systems were: *i.* plough (P), *ii.* two-layer plough (LP) and *iii.* layer cultivator (LC). The research project was initiated in 1995 by the Foundation for Ecology & Agriculture, Bad Dürkheim, Germany. Samples from the 'No tillage' system (NT) were taken from a site which was located directly in the neighbourhood of the experimental field. This site has been under no till since 17 years according to the sampling date.

The soils at the study site was a calcareous chernozem. For soil analysis, samples were taken from green fallow plots from the surface (0-15 cm depth) and subsurface (15-30 cm depth) in spring 2002 at the beginning of the vegetation period.

3. Results

Significant effects were found in the direction P – LP – LC – NT:

- Increase in soil organic matter content (SOM; C_{org}) in the top layer (0 – 15 cm depth).
- As a tendency SOM was decreased in 15 – 25 cm depth. Thus, the differences between both sampling depths were increased.
- As a consequence of increased decomposition of SOM in ploughed soils the mobile fractions of SOM (WEOC) were decreased in P and LP related to LC and NT.
- Amounts of soil microbial biomass – C and microbial activity (AWCD – BIOLOG™) were highly correlated with SOM.
- The functional diversity of gram – negative bacteria was increased.
- The fungi – to – bacteria ratio changed towards fungi.
- Patterns of Phospholipid – Fatty acids (PLFA) revealed changes in the composition of the soil microbial community.

4. Conclusions

Reduced and conservation tillage, and no tillage modified the amounts and quality of soil organic matter and thus the composition of soil microbial community relative to plough. Microbial biomass and activity and the fungi – to – bacteria ratio increased in the direction plough – two layer plough – layer cultivator – no till.

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