Effects of organic versus conventional farming on different chemical soil parameters in Estonia

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Implications

A five-year experiment results, have shown that fertilizer amendments are needed for preserving the nutrient balance in the soil. A combination of cattle and green manure, crop rotation and other organic farming practices, with chemical fertilizer amendments could suppose a sustainable solution for maintaining a correct nutrient balance in the soil in long term, better than both farming systems, conventional and organic, by separate.

Background and objectives

The problems associated with conventional management in agriculture such as decline of organic matter, soil erosion, soil and water pollution, etc. united to the new European policy to develop more environmentally sensitive farming practices, have boosted the development and investigation in organic farming as an alternative agricultural management. In the case of Estonia, it has experimented an increasing importance after the re-establishment of the independence in 1991 due to government support, registering in 2012 a total of 134.057 organic farming hectares (14% of all agricultural land in use). There are many studies which compare different soil parameters under conventional and organic farming management, but controversy in results make still difficult for farmers to choose between one or the other. The aim of this study is to compare the evolution of several soil chemical parameters under different farming conditions based on different nutrient amendments, in order to provide a better understanding of organic farming soils, and promote the government support for this kind of agricultural practice.

Key results and discussion

Comparing the evolution after five years of certain chemical parameters in the same soil managed under organic or conventional conditions, some remarkable differences are observed. In terms of soil acidity, no significant year-to-year variations ($P<0,05$) were shown for any of the treatments. Soil organic carbon (SOC) showed a significant increase at the end of the experiment in the ORG. II plots. Several researches like Hoyt and Rice in 1977 or Mathers and Steward in 1984, have reported similar results of organic carbon in soils after following manure application for several years. Meanwhile the unfertilized conventional plots showed marked losses in N_{tot}, the rest of the treatments showed a slightly decrease in this nutrient in the soil, which could suppose a limitation in crop growth if same experiment is run in long-term. According with the results, either green manure or cattle-green manure fertilization are not enough in the organic plots for maintaining a positive balance in terms of P and K. Conventional fertilized plots ($N_{125}P_{25}K_{95}$) showed an increase in phosphorus but as happened with the organic ones, it has significant losses of potassium with time. Berry et al. (2003) among other authors have found that organic managed plots in long term accused deficits of P and K but also N, which directly affects to the crop yield (Rodrigues et al., 2006).

Table 1. Comparison of the different soil parameters analyzed between the beginning of the starting year of the experiment (2008) and the last year (2012). $N_0P_0K_0$ (conventional plots without addition of fertilizers), $N_{125}P_{25}K_{95}$ (conventional fertilized plots), ORG.I (organic plots with green manure), ORG. II (organic plots with green manure and cattle manure. Mean nutrient values of manure: Ctotal: 13.76, Ntotal: 0.97, Ptotal: 0.45, Ktotal: 0.86 and dry matter content: 44.8.).

	$N_0P_0K_0$	$N_{125}P_{25}K_{95}$	ORG. I	ORG. II
pH	-0,05	-0,1	0,04	0,14
C_{org} (%)	0,05	-0,03	0,11	0,34*
N_{tot} (%)	-0,017*	-0,002	-0,003	-0,008
P (mg kg^{-1})	-4,5	8,7	-19,9*	-12,9*
K (mg kg^{-1})	-34,2*	-20,9*	-35,6*	-20,2*

+/-: decreasing or increasing tendencies. *: significant differences (*P<0,05*) comparing the average values from 2008 and 2012.

How work was carried out?

The field experiment was situated at the experimental station of the Estonian University of Life Sciences in Eerika, Tartu, Estonia (58°22'N, 26°40'E) since 2008 on *Albic Stagnic Luvisol* soil. It consist on 80 plots, 40 of them cultivated under conventional farming system with different concentrations of mineral fertilizers (no addition of chemical fertilizers: $N_0P_0K_0$ and $N_{125}P_{25}K_{95}$), and the remaining 40 plots cultivated under organic farming conditions with the same rotation but having winter oil-rape after pea, winter rye after potato and ryegrass after winter wheat as cover crops. In addition 20 of them (ORG. II) receive yearly 40 t ha^{-1} of manure in those plots were pea is cultivated, except the last year when manure was divided between winter wheat 10 t/ha, barley 10 t/ha and potato 20 t/ha.

Soil samples were collected once a year in April, before any field operation, taking eight replications per plot from 0 to 25 cm depth. Each air-dried soil sample was sieved through a 2 mm sieve and mixed in a KCl solution 1M (1:2,5) for determining the pH, meanwhile the organic carbon concentration was determined by the Tjurin method and total nitrogen was measured after Kjedal digestion. The concentrations of plant available nutrients P and K in the soil were determined by the ammonium lactate (AL) method.

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